Lake Manitou
Aquatic Vegetation Management Plan Update,
Fulton County, IN
March 14, 2008

Prepared for:
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Executive Summary

SePRO Corporation was contracted by the Indiana Department of Natural Resources (IDNR) to complete aquatic vegetation sampling to update the 2005 Lake Manitou long-term integrated aquatic vegetation management plan. Funding for development of this plan was obtained from IDNR. Items covered include the 2007 sampling results and discussion, a review of the 2007 vegetation management effort, and updates to the budget and action plans.

Historically, Eurasian watermilfoil (*Myriophylum spicatum*) was the primary focus of vegetation management in Lake Manitou prior to the 2007 season. Hydrilla (*Hydrilla verticillata*), however, was discovered in the late summer of 2006. Hydrilla is an exotic invasive species that can form dense populations that disrupt ecosystems, displace native species, and impair fish and wildlife habitat. This was the first confirmed case of hydrilla in the Midwest. Hydrilla can be easily spread through fragmentation, so control of this species took precedent over all other aquatic vegetation management in Lake Manitou. Hydrilla was described as “The Perfect Aquatic Weed” due to its growth habit, multiple modes of propagation, and other competitive advantages compared to some native plant species (Langeland 1996). Hydrilla could rapidly spread inter-lake and intra-lake to depths of 20-feet or more (depending on water clarity), displace most other submersed vegetation, and severely restrict boating and other recreational activities. IDNR took quick action by closing all ramps, public and private, on the lake, and contracted the application of a fast-acting contact herbicide (i.e. Komeen; a.i. chelated copper) to reduce the potential for spread of vegetative fragments. Komeen was applied to approximately 20 acres of hydrilla (the Poet’s Point area in the northern section of the lake, and near the City ramp).

The Indiana Department of Administration and IDNR issued a Request For Proposal for hydrilla eradication on Lake Manitou on January 26, 2007. SePRO Corporation (hereinafter referred to as SePRO, Carmel, IN) compiled a comprehensive program including hydroacoustic mapping of the lake, aquatic vegetation and hydrilla tuber sampling, water quality monitoring and an aggressive treatment program utilizing Sonar (a.i. fluridone) aquatic herbicide. SePRO was awarded a three year contract for the hydrilla eradication project, and quickly teamed with ReMetrix LLC (Carmel, IN), Aquatic Control, Inc. (Seymour, IN) and Aquatic Weed Control, Inc (Syracuse, IN) to complete the project.

A Team meeting was held on April 12 in order to assign duties and coordinate plans for the 2007 season. Tuber sampling occurred May 14 to 17, and established five permanent stations where tuber sampling would take place for at least the next three years.

The initial Sonar application was initiated on May 17, with the objective of maintaining > 6 ppb for 180 days. This application was completed with a combination of Sonar AS and Sonar Q. A Tier II aquatic vegetation survey was completed on May 31 and indicated that hydrilla was severely damaged by the initial treatment. A “bump” application was completed using Sonar Q and AS on June 27. FasTEST sampling and visual plant

observations continued throughout the summer. A Tier II survey was conducted on August 27. No hydrilla was collected or observed. Results also indicated a reduction in submersed native species abundance and diversity. The unseasonably dry summer likely contributed to higher Sonar concentrations, and increased native plant injury by decreasing expected dilution of herbicide residues. Tuber sampling was again completed on September 17, c.a. 5 months after initial treatment. Sampling revealed hydrilla tuber numbers were significantly reduced (86% total reduction) from pretreatment densities, however, as expected viable tubers remained.

The pellet formulation of Sonar (Sonar Q) was predominately used to maintain herbicide residues. Sonar release from the pellet occurs over a period of several weeks that would compensate for the expected dilution of Sonar in Lake Manitou from rainfall. Therefore, modifications to the 2008 treatment prescription for Sonar were recommended attempting to ncrease treatment selectivity, following consultation with IDNR. Sonar pellet formulations (Sonar PR) will be applied to only areas where hydrilla was previously reported, and at the inflow, instead of the entire littoral zone. The whole lake concentration will be maintained > 3 ppb using Sonar A.S. (instead of 6 ppb in 2007), with more frequent bump applications to minimize exposure to relatively high concentrations.

The treatment program provided successful control of hydrilla biomass throughout the season. No viable hydrilla plants were noted in any reconnaissance surveys following the initial Sonar application. Continued aggressive treatment with Sonar aquatic herbicide in 2008 is recommended. The following is a list of actions that should be completed in 2008:

1. Continue with similar Sonar applications and residue monitoring, with slight modification to formulations used, rates applied, and sample scheduling/locations. Anticipate an increased number of Sonar bump treatments during the 2008 treatment season. Spring and summer of 2007 were among the driest on record for the Lake Manitou region, which reduced overflow and herbicide dilution. It is unexpected that a second year of drought similar to 2007 will occur in 2008.

2. Complete two Tier II surveys, two tuber sampling surveys, and regular reconnaissance surveys in order to monitor the treatment effectiveness and impacts on native vegetation. Spring tuber sampling (2008) should attempt to locate dense beds of hydrilla propagules by conducting random sampling in known hydrilla areas that were not surveyed in 2007. Fall tuber sampling will focus sampling at the 5 permanent tuber locations identified in 2007, with increase sampling expected as tuber densities decrease.

3. Maintain ramp closures and inspections until sampling can be completed that indicates there is no vegetative hydrilla present in Lake Manitou. The actions to eradicate and isolate hydrilla to Lake Manitou have, without question, reduced the potential for spread to other waters in Indiana and the Midwest.

4. IDNR should continue with public education efforts in an attempt to prevent additional hydrilla introductions.

5. IDNR should consider completing a fish survey on Lake Manitou in order to assess any changes in the fish population following the treatment, and subsequent reduction in submersed vegetation abundance.

6. Assuming a similar rate of reduction in tuber numbers in subsequent years, it would take a minimum of 3 years to get a 99.5% reduction in hydrilla tubers. Based on experiences at Long Pond, MA (see references), this high rate of initial attrition is not expected subsequent years. In Long Pond, tubers declined at a similar rate as observed on Lake Manitou after the first year Sonar treatments, but then attrition rates were reduced likely as a result of tuber dormancy mechanisms. Recognizing tubers can survive for at least 4 years (Van and Steward 1990), and the fact there was still vegetative hydrilla in Lake Manitou in 2007, this program should continue into at least the 2010 season. Adjustments to the eradication program may be necessary and monitoring the tuber bank is crucial.

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Acknowledgements

Funding for vegetation sampling, herbicide treatment, and preparation of the aquatic vegetation management plan was provided by the IDNR. Aquatic Control, Inc., Aquatic Weed Control, Inc., ReMetrix LLC, and SePRO completed the fieldwork, data processing, and map generation. Special thanks to Mr. Doug Keller and Ms. Gwen White, Invasive Species Coordinator and Aquatic Biologists from the IDNR, for their review and assistance on this plan. In addition, special thanks are given to Mr. Orv Huffman and the Lake Manitou Association for their assistance with this project. Authors of this report are Mr. Nathan Long of Aquatic Control, Inc., Dr. Tyler Koschnick and Mr. Bob Johnson of SePRO, and Mr. Doug Henderson of ReMetrix LLC. The authors would like to acknowledge the valuable input from the staff of SePRO, Aquatic Control, Inc., Aquatic Weed Control, Inc., and ReMetrix LLC.

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1.0 INTRODUCTION

This report was created in order to update the Lake Manitou Aquatic Vegetation Management Plan. The original plan and updates through 2006 were funded by IDNR and the Lake Manitou Association (Donahoe & Keister 2005-2007). The following management goals were established by the original plan:

1. Develop or maintain a stable diverse aquatic plant community that supports a good balance of predator and prey fish and wildlife species, good water quality, and is resistant to minor habitat disturbances and invasive species.
2. Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species.
3. Provide reasonable public access while minimizing the negative impacts on plant and wildlife species.

Lake Manitou is an 809-acre lake located in Fulton County, Indiana. The primary purpose of the vegetation sampling and plan update is to document hydrilla eradication activities and to adjust the management plan as needed following the introduction of hydrilla into Lake Manitou in 2006. Items covered include the 2007 sampling results, a review of the 2007 vegetation management activities, and updates to the action plan. Once reviewed and approved, the update should be included in the original vegetation management plan, following the 2006 update but prior to the appendix.

The original Lake Manitou Aquatic Vegetation Management Plan was created in 2004 and updates were completed in 2005 and 2006. The control of Eurasian watermilfoil was the primary objective of the previous plan and updates. This changed in August of 2006 when IDNR discovered hydrilla during a routine Tier II survey. This discovery precipitated a rapid response by IDNR Invasive Species Coordinator, Doug Keller. Suspected hydrilla samples were first sent to Dr. Robin Scribalio, Aquatic Botany Professor at Purdue University, North Central. These samples were confirmed to be hydrilla. Additional specimens were sent to Dr. Mike Netherland, U.S. Army Corps of Engineers-Aquatic Plant Research, Gainesville, FL; Dr. Lars Anderson, University of California – Davis; and Dr. John Madsen at Mississippi State University for confirmation. Dr. Madsen confirmed the initial identification and felt that the plants morphologically looked like monoecious hydrilla. Dr. Netherland grew the plants under long and short-day conditions. The plants produced tubers under long-day conditions, thus confirming that the sample was monoecious hydrilla (pers. comm., Doug Keller).

Upon confirmation of species, access to the lake was immediately closed to the public to prevent the potential for spread through boats and boat trailers. The ramps were only open at predetermined times during 2006 and 2007 to allow those living around the lake an opportunity to get their boats on the lake or remove them for winter storage. During these times, boats were inspected for potential hydrilla fragments. No public access was permitted to the lake following hydrilla discovery in 2006 and all of the 2007 use season (Figure 1).

Figure 1. Advisory signs posted at the public launches on Lake Manitou.

Hydrilla is an exotic invasive species that can form dense populations that disrupt ecosystems, displace native species, and impair fish and wildlife habitat. It has unique physiological and biological characteristics that can create a competitive advantage over many native submersed plant species, and has been termed “The Perfect Aquatic Weed” (Langeland 1996). Hydrilla has a low light and CO_2 compensation point compared to some native submersed plant species (Van et al. 1976); can switch between C_3 and C_4 carbon utilization under limiting conditions (Rao et al. 2002); forms dense canopies at the water surface which limits light penetration (Haller and Sutton 1975); and can have up to 85% of its biomass in the top 2 feet of water. Hydrilla can create an environment that is difficult for other plant species to effectively grow and compete (Figure 2). If hydrilla was not eradicated or the spread contained, it likely would rapidly spread to other waters, form monocultures of vegetation, impede recreation, reduce biodiversity, and result in biological pollution in many shallow lakes of Indiana.

Figure 2. Dense monoculture of hydrilla.

Lake Manitou was the first confirmed location of hydrilla in the Midwest. Hydrilla is the number one aquatic plant problem in the U.S. with more money expended on management than for any other aquatic plant species. Other states have taken aggressive approaches against hydrilla recognizing the potential impact this species can have on recreation, water conveyance, biodiversity, and water use. California legislatively mandated an eradication program after the plant was identified in the State in 1976; Washington and Maine enacted eradication programs shortly after identifying hydrilla; hydrilla was discovered in Wisconsin in 2007 with eradication efforts underway. Hydrilla can be easily spread through fragmentation, so control of this species took precedence over all other aquatic vegetation control efforts on Lake Manitou. Shortly after discovery, IDNR personnel mapped the hydrilla population in Lake Manitou and contracted Aquatic Weed Control, Inc., to treat approximately 20 acres of hydrilla in the lake with Komeen (the Poet's Point area in the northern section of the lake, and near the City ramp). The treatment was effective in controlling extant hydrilla biomass in the treatment areas to reduce potential for vegetation spread in Lake Manitou and downstream. Further surveys conducted independently by IDNR personnel and SePRO personnel (Figure 3) confirmed additional sites in the lake with hydrilla. This led to a Request For Proposal (RFP) for a comprehensive hydrilla eradication program for Lake Manitou.

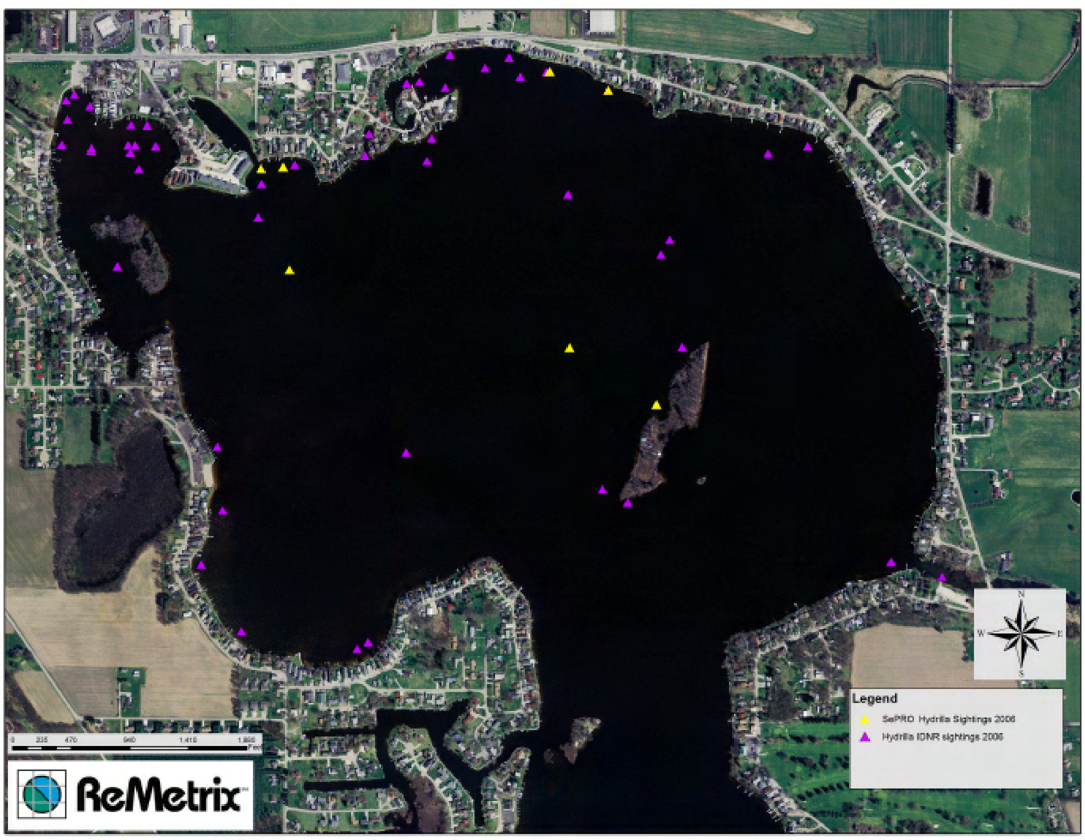

Figure 3. Sites identified with hydrilla during 2006 surveys. Magenta triangles = sites identified with hydrilla by IDNR on 9-25-06. Yellow triangles = sites identified with hydrilla by SePRO on 10-5-06.

SePRO Corporation was awarded a three-year contract and assembled a team focused on the management of vegetation in Lake Manitou, with the objective of hydrilla eradication. The team consisted of personnel from Aquatic Control, Inc., Aquatic Weed Control, Inc., ReMetrix LLC, and SePRO. The following three sections will outline the sampling and treatment activities completed in 2007. The final sections of the update include recommendations for future actions aimed at hydrilla control, and recommendations for the Lake Manitou Vegetation Management Plan.

2.0 SAMPLING METHODS

In 2007, Lake Manitou's vegetation was surveyed using several different methods. Hydrilla tuber sampling was initiated on May 14 and again on September 17 to monitor depletion of the tuber bank. Standard Tier II surveys (Indiana Department of Natural Resources, 2006) were completed on May 31 and August 27 to monitor hydrilla population and quantify native species abundance. In addition, visual observations of the plant community were recorded throughout the season. These observations aided in the timing of initial Sonar application, surveyed for potential hydrilla biomass, and provided insight into the progress of the treatments. Table 1 is a summary of 2007 plant survey activities on Lake Manitou.

Table 1. Summary of 2007 Plant Surveys on Lake Manitou. 2007 herbicide treatment dates: May 18 (initial Sonar); June 6 (2-acre contact herbicide by IDNR); June 27 (Sonar bump).

Date	Type of Survey
April 12	Reconnaissance Survey
May 2	Reconnaissance Survey
May 11	Reconnaissance Survey
May 14-17	Tuber sampling
May 21	Reconnaissance Survey
May 31	Tier II Survey
June 15	Reconnaissance Survey
June 26	Reconnaissance Survey
July 13	Reconnaissance Survey
July 26	Reconnaissance Survey
August 9	Reconnaissance Survey
August 23	Reconnaissance Survey
August 27	Tier II Survey
September 17	Tuber Sampling
September 18	Reconnaissance Survey

2.1 Reconnaissance Surveys

For reference: the initial Sonar treatment was conducted on May 18, 2007; the 2-acre site adjacent to the IDNR public access site was treated June 6; the bump Sonar treatment was conducted on June 27, 2007. Details of the treatments can be found in Section 4.0.

2.1.1 Pre-treatment Reconnaissance Surveys

Reconnaissance surveys were completed to coordinate the initial Sonar treatment with the onset of hydrilla growth. On April 12, 2007 a joint inspection by SePRO and Aquatic Control, Inc. personnel was made in known hydrilla areas. No hydrilla was observed. A second survey was conducted on May 2. Treatment signs were posed several areas around the lake to notify people about the Sonar treatments as well as the water use restrictions once applications began. Over 25 rake tosses were made and no hydrilla tubers or vegetative hydrilla were collected. Several small pondweed and eelgrass sprouts were found. Another survey was conducted on May 11 to assess vegetation growth and measure for potential thermal stratification (Table 2). No hydrilla was observed, but several patches of large leaf pondweed (*Potamogeton amplifoilous)* and Chara (*Chara spp.)* were noted. Hydrilla was not observed sprouting until May 14 during the initial tuber sampling effort, which will be further discussed in Section 2.2.2.

Table 2. Lake Manitou water temperature profile, May 11, 2007. *(Data collected by B. Johnson, SePRO Corporation.)*

Depth (ft)	Fahrenheit	Celsius
Sub-surface	71.0	21.7
2	69.8	21.0
4	68.9	20.5
6	67.5	19.7
8	64.5	18.1
10	63.2	17.3
12	62.2	16.8
14	61.7	16.5
16	61.3	16.3
18	61.0	16.1
20	60.0	15.6
22	59.5	15.3
24	59.4	15.2
26	59.1	15.1
28	58.7	14.8
30	57.8	14.3
32	57.4	14.1

2.1.2 Post-treatment Reconnaissance Surveys

Reconnaissance surveys were primarily completed during FasTEST collections. Plant surveyors followed a pre-determined route designed to maneuver over known areas of hydrilla (Figure 4). Along with collecting FasTESTs, personnel recorded information at each of the 8 sample sites on plant species presence, injury, cover, and growth ratings; secchi depth; and surface temperature. Dissolved oxygen/temperature profiles were also taken at the predetermined FasTEST sites denoted 2 and 7. Water samples were collected on four separate occasions to monitor orthophosphate, total phosphorus, total nitrogen, nitrite/nitrate, conductivity, and chlorophyll a (water quality monitoring will be discussed further in Section 3.0). Individual monitoring data sheets are included in the Appendix. A summary of observations made along the reconnaissance survey route is provided in Table 4.

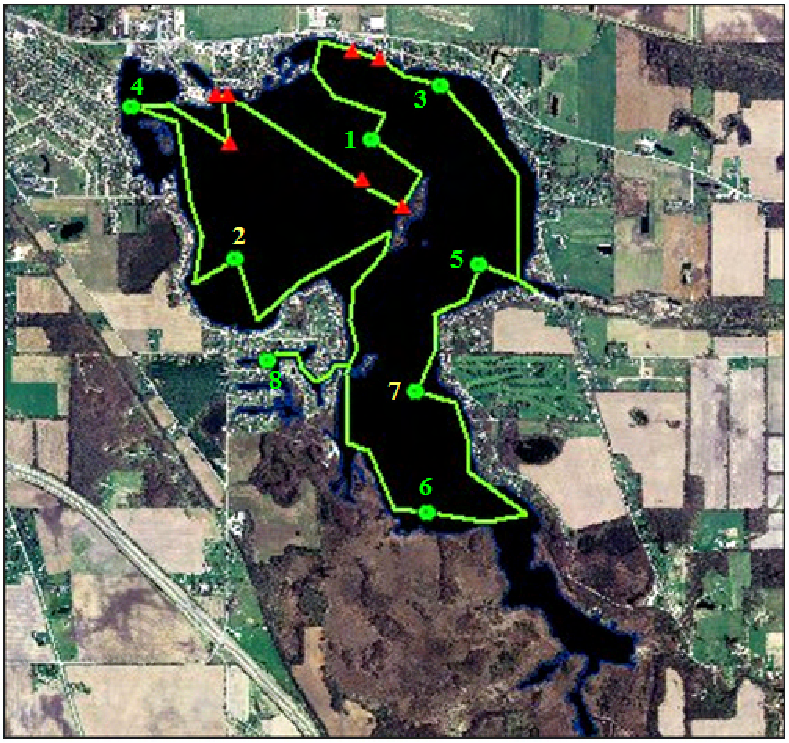

Figure 4. FasTEST monitoring/vegetation reconnaissance survey route. The green line shows the route. Green points are the FasTEST monitoring sites with corresponding site numbers. Yellow site *numbers* are the two deep-water sampling sites. Red triangles are locations where hydrilla was found during the 10-06 survey by SePRO, and are displayed to show that the reconnaissance survey was designed to include some known hydrilla sites as part of the regular monitoring route.

Table 3. Latitude and longitude coordinates for the eight FasTEST monitoring stations.

Site #	Latitude	Longitude
1	41.057241	-86.179153
2	41.051644	-86.187588
3	41.059832	-86.174896
4	41.058761	-86.172360
5	41.051391	-86.172360
6	41.039812	-86.175586
7	41.045421	-86.176326
8	41.046891	-86.185433

Table 4. Lake Manitou, FasTEST collection plant monitoring summary.

Collection Date	Surface-temp range (°F)	Secchi depth (ft)	Species Observed and Injury Rating[a]
May 17	65.0-69.0	6.0-9.0	eelgrass (1,3), lg. leaf pw (3), EWM (3), CLP (1), coontail (1)
June 15	78.8-82.9	3.0-5.8	eelgrass (1,3), sago pw (1), hydrilla (4), coontail (2), watermeal (1)
June 26	78.7-81.1	2.6-5.5	eelgrass (3), duckweed (2), coontail (4), watermeal (1)
July 12	78.7-80.4	3.9-5.3	eelgrass (3), coontail (4), sago (2), Chara (1), duckweed (2), CLP (1), watermeal (1)
July 26	74.7-77.4	3.2-4.6	duckweed (2), watermeal (1)
August 9	84.3-86.6	3.1-3.9	duckweed (2), watermeal (1), Chara (2)
August 23	77.0-80.0	2.6-4.2	duckweed (2), watermeal (1)
September 18	68.2-76.2	3.0-4.3	n/a
October 17	62.4-65.1	4.0-6.1	n/a
November 13	48.3-49.7	3.8-4.9	Chara (1)

[a] Injury rating from 1-6 (1-healthy, 2-slight injury, 3-moderate injury, 4-severe injury, 5- dead plant, 6 – not present (lg. leaf pw = large leaf pondweed; EWM = Eurasian watermilfoil; CLP = curlyleaf pondweed; sago pw = sago pondweed).

2.1.3 Reconnaissance Survey Discussion

A reconnaissance sampling route was established to provide routine visual observations and rake tosses to monitor plant response to Sonar treatment program, and search for vegetative hydrilla growth. This route and additional random sampling activities were completed on each FasTEST sampling date. Surveying in conjunction with water sampling provided a rapid and cost effective means of assessing the effectiveness of the treatment program. This information was used in determining the timing and necessity of bump treatments, along with FasTEST results.

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2.2 Tuber Sampling

2.2.1 Tuber Sampling Protocol

Monoecious hydrilla has the ability to reproduce both sexually and asexually. Asexually hydrilla can spread through fragmentation or through turion and tuber production. The ability of hydrilla to form tubers creates one of the greatest challenges for eradication of this species. Hydrilla can produce greater than 30 million tubers per acre under experimental conditions (Steward and Van 1987) and up to 5 million under field conditions (Harlan et al. 1985); forms tubers under short as well as long-day conditions (up to 16 hour days) (Sutton et al. 1992, Netherland 1997); and produces tubers relatively rapidly (Van 1989). Although monoecious hydrilla can form tubers under both long and short-day conditions, the production during long-day conditions (summer in the Midwest) and its rapid growth potential make it unique from dioecious hydrilla. The dioecious hydrilla biotype is predominately found in the Southern US and produces tubers solely under short-day conditions or fall/winter (Netherland 1997).

Initial tuber sampling on Lake Manitou focused on finding sediments that actually contained hydrilla tubers. Once tubers were located, five (5) permanent sampling stations were established at those points and referenced using GPS waypoints. These stations will be rigorously sampled to determine impact of management on tuber densities over time.

The objective of the tuber sampling is not to document the distribution of tubers, but to find areas of dense tubers and document the attrition rate resulting from management. Therefore, the frequency of sampling isn't as important at the intensity of sampling. Additionally, new tubers should not be formed under continuous control operations.

Spencer et al. (1994) reported that the quantity of sediment cores sampled to estimate the abundance of tubers is inversely correlated to tuber densities. Low density areas require 27-234 samples to precisely determine tuber densities, and 8 to 26 samples should be collected in areas of high tuber density. Sediment core sizes ranging from 2 to 6 inches did not influence precision. Generally, the majority of tubers are isolated to this depth (Harlan et al. 1985, Netherland 1999).

2.2.2 Pre-treatment Tuber Sampling Results

Initial tuber sampling was completed May 14-May 17. This was one of the most time-consuming and labor-intensive tuber sampling events due to the need to locate permanent sampling stations. A total of 562 sediment core samples from 126 sites were collected to locate sediments containing hydrilla propagules (Figure 5). Due to the incipient stage of hydrilla infestation and lack of detailed coverage maps, hydrilla was difficult to find in high densities.

Figure 5. Tuber sampling locations from May 14-17, 2007. Green points represent areas where no hydrilla tubers were found. Red points indicate where hydrilla tubers were collected.

Tuber sampling equipment is shown in Figure 6. This sediment core sampling device was modified from the version described by Madsen et al. (2007), with galvanized pipe and schedule 40 pressure PVC (Figure 7). Galvanized pipe was ¾ inch in diameter, and connected air tight to the PVC coring head with a gasket, and a ¾ inch ball valve for venting. The coring head was a 4” PVC pipe with a length of ~18 inches.

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Figure 6. Tuber sampling equipment and personnel.

Figure 7. Coring device used for colleting sediments for tubers collections at Lake Manitou.

At each site (waypoint), typically 4 individual core samples were collected and sorted using wash racks/buckets with 5/32 inch holes. Samples were rinsed in the lake to prevent transportation of tubers. Cores were 4 inches in diameter and ranged in depth from 4-20 inches. Core depth, sediment type, and number of hydrilla tubers and/or turions were recorded. Although not part of the overall hydrilla control contract, eelgrass tubers were also enumerated. All collected hydrilla tubers were placed in a plastic bag and disposed of by placing in household trash as directed in IDNR "Compliance Agreement For Hydrilla Containment at Lake Manitou." Rake tosses (minimum 4) were added at each site to sample a larger area for hydrilla.

Five permanent tuber sampling stations were identified based on hydrilla propagules collected and presence of vegetative tissue (Figure 8). At each station, 50 core samples were taken (total 250) at random from around the permanent station waypoints. The majority of hydrilla propagules were already sprouted, and only a single turion was found. Length of hydrilla and tuber to tip of sprout averaged approximately 4 to 5 inches. The results of the sampling are listed below in Table 5.

Figure 8. Locations of the five permanent hydrilla propagule monitoring stations, with station numbers.

Table 5. Summary data for 5 permanent hydrilla propagule monitoring stations, May 2007. Fifty (50) four-inch cores were pulled from each station (total area = 21.85 ft^2 or 0.0005 acre) in May 2007 (pre-treatment).

Site	Waypoint	Sprouting hydrilla tubers	Non-sprouting hydrilla tubers	Sprouting hydrilla turions	Eelgrass tubers	Sample area (ft^2)
Lighthouse Bay – Station 1	083 T1	8	0	0	101	1750
Dollar Store Bay – Station 2	084 T1	16	21	0	148	1250
White dock – Station 3	085 T1	34	14	1	78	400
Poet's Point – Station 4	086 T1	40	2	0	1	750
Poet's Bay – Station 5	087 T1	11	3	0	0	1250
TOTAL	-	109	40	1	328	5400

2.2.3 Post-treatment Tuber Sampling Results

On September 17 a second round of tuber sampling was completed. This sampling event took less time since sampling station were already established. The five established permanent tuber sampling stations were sampled with 50 4-inch core samples taken from stations 2 and 3, 53 cores from station 4, and 75 cores taken from stations 1 and 5. An additional 27 core samples were taken around and expanded area of Station 1 which included the channel connecting the lighthouse bay area to the small cove. Similar sampling methods were used as described in Section 2.2.2. The number of cores will increase with time to locate remaining tubers as tuber densities decrease in response to management. At each station, a minimum of 50 cores were sampled, and if tubers were documented then no additional samples were collected. If tuber densities were low or no tubers were found in the first 50 samples, sampling frequency increased to a maximum of 102 cores (Station 1 expanded) to locate tubers. The results of the sampling are listed below in Table 6.

Table 6. Summary data for 5 permanent hydrilla propagules monitoring stations, September 2007. Fifty (50) 4-inch core samples taken from stations 2 and 3, 53 cores from station 4, and 75 cores taken from stations 1 and 5 (total area = 26.5ft^2 or 0.00061 acre) in September, 2007 (4 months post-treatment)**.**

Site	Waypoint	Sprouting hydrilla tubers	Non-sprouting hydrilla tubers	Sprouting hydrilla turions	Eelgrass tubers	Sample area (ft^2)
Lighthouse Bay – Station 1	083 T1	0[a]	0	0	0	2075
Dollar Store Bay – Station 2	084 T1	0	2	0	0	2500
White dock – Station 3	085 T1	2	2	0	0	1250
Poet's Point – Station 4	086 T1	2	8	0	0	1000
Poet's Bay – Station 5	087 T1	1	5	0	0	1750
TOTAL	-	5	17	0	0	8575

[a] 2 sprouting tubers (1 at the entrance and exit to the channel on the N side) were found in expanded area at the channel that connects the main lake basin to the small cove on the North end of the lake.

A brief summary of field notes and results from the tuber sampling program for both May and September is included in the Appendix.

2.2.4 Tuber Sampling Discussion

Tubers were found with 2 to 6 inch sprouts on May 14th (Figure 9). Surface water temperatures at this time were approximately 19^{o}C (66^{o}F) and deep water temperatures at the sediment layer were approximately 9^{o}C (48^{o}F) (Table 7). Water temperature at 4 to 5 feet was approximately 15 to 19^{o}C, the depth at which many tubers were collected. The timing of sprouting observed in Lake Manitou is consistent with reports from Steward and Van (1987), who reported that tubers sprout at 15^{o}C (59^{o}F)

Figure 9. Hydrilla tubers and a turion found sprouting in Lake Manitou (May 2007).

Table 7. Water temperature and dissolved oxygen profiles at FasTEST stations 2 and 7 on May 16, 2007. *Data was collected two days before the initial Sonar application (May 18, 2007). Water gauge reading at the dam ~16 hours after collection was 8.30. Establishment of thermocline at each site is highlighted. Based on data, Sonar was applied to the upper 17-feet (5.2-meters) of the water column.*

May 16, 2007				
Depth (m)	Temp (C)		DO (mg/L)	
	Site 7	Site 2	Site 7	Site 2
Sub-surface	19.6	18.9	8.45	8.66
1	19.6	18.9	8.33	8.56
2	19.5	19.0	8.21	8.63
3	19.5	19.0	8.17	8.25
4	19.4	18.3	8.22	7.29
5	19.4	15.9	8.32	5.77
6	16.3	15.1	5.71	4.91
7	13.5	13.3	4.51	3.07
8	12.1	10.7	4.09	0.73
9	10.6	9.6	3.25	0.20
10	9.5	9.3	2.33	0.12
11	8.9 (bottom)	9.0	0.36	0.09
12	8.6	n/a	0.20	n/a
13	8.6 (bottom)	n/a	0.13	n/a

n/a = not applicable

Tuber sampling data indicates a significant reduction in hydrilla tubers at the 5 established sampling stations after the initial Sonar treatment program. Overall there was an 86% reduction in the total number of tubers collected from these stations (Table 8). Tubers were grouped according to those that were dormant (non-sprouting) vs. actively sprouting (sprouting). From May to September, there was a 95% reduction in the number of sprouting tubers. This suggests that there was a significant portion of the tuber bank that sprouted in 2007. There was a 63% reduction in the number of non-spouted or dormant tubers that were collected. This indicates there may have been some additional sprouting throughout the year, which is supported by finding sprouted tubers in September. This indiscriminate sprouting, throughout the year, has been previously reported by Netherland (1999) for dioecious hydrilla.

This overall high rate of tuber attrition was not expected. Netherland (1999) reported a c.a. 7% annual reduction in dioecious hydrilla tubers following intense management. The tuber dormancy mechanism in monoecious hydrilla may be different than dioecious hydrilla. Generally, there is a lack of literature on monoecious hydrilla tuber bank changes following management. SePRO, in cooperation with N.C. State University (Dr. Rob Richardson) initiated studies in 2007 to document monoecious hydrilla tuber densities following Sonar treatments. The findings on Lake Manitou are consistent with data collected from Lake Gaston, NC and Tar River Reservoir, NC (Koschnick et al. 2008). All sites were treated with Sonar; in addition to the Sonar, there was a drawdown on Tar River, and a low rate of grass carp stocked on Lake Gaston. There was a 55 to 90 percent reduction (mean 55%) in tubers on Lake Gaston at sites treated with Sonar (untreated sites had a -30 to +76% change in tubers). On Tar River, there was a 66% reduction in tubers.

This initial high rate of tuber attrition was also observed on Long Pond, MA (Long Pond 2006). Long Pond has been treated every year with Sonar since 2002 for hydrilla control. Tubers collected in the spring (pre-treatment every year) have reduced annually since the first year of treatment (from 77 to 13 to 10 to 10 to 8). There was an 83% reduction in tubers the first year, then a 23%, 0%, and 20% reduction in subsequent years following Sonar treatment. This possibly suggests that dormancy may be prolonged in some monoecious hydrilla tubers.

As tuber reduction occurs as a result of management, sampling regimes will be modified to reflect changes in abundance. Additional sites may be included or additional cores will be sampled from each site. As tuber densities approach zero through time, more rigorous sampling will be employed at each permanent station. As eradication efforts continue on Lake Manitou, hydrilla occurrence should be monitored closely for several years after control programs cease. Tuber sampling will ultimately determine the effectiveness of the eradication program, but at some point it will be impossible to collect sufficient cores to document “zero” hydrilla (tubers). Therefore, sampling intensity will be balanced with reasonable expectations for the number of sediment cores that can reasonably be assessed.

Table. 8. Summary of hydrilla tubers collected pre (May) and post (September) Sonar treatment in 2007. Data corrected for total area sampled (core was 4 inches with an area of 0.0876 ft^2; 50 core samples = 0.0001006 acres and 75 cores = 0.0001508 acres). Data presented as the total number of tubers per acre assuming uniform distribution.

	Sprouting		Non-sprouting	
	Pre	Post	Pre	Post
Station 1	79,522	9,747	0	0
Station 2	159,046	0	208,748	19,881
Station 3	337,972	19,881	139,165	19,881
Station 4	397,614	18,779	19,881	75,117
Station 5	109,344	6,631	29.821	33,156
MEAN	216,700	11,008	79,523	29,607
% change (pre to post)	95%		63%	

Extensive tuber sampling is crucial for the long-term success of the eradication effort. However, tuber distribution is not uniform, instead has a non-random, clumped distribution (Netherland 1997). Even in areas with dense hydrilla, tuber density varies tremendously (Haller et al. 1976). If the management objectives are met, most existing above ground biomass of hydrilla in Lake Manitou will not be observed due to ongoing control efforts. Thus, the result of the eradication efforts might result in a perception that there is no longer a need for hydrilla control. Therefore, extensive tuber sampling is crucial for the long-term success of the program. It is not known why tuber distribution is clumped, but likely influenced by tuber formation rather than solely a factor that causes greater mortality at one area versus another. Sampling sites were located where the highest tuber densities were found during preliminary sampling. Recognize the limited amount of area that can be sampled and the relatively small percentage of hydrilla in the lake made this a difficult task. We are not assuming we found the only tuber beds or that these sites represent the distribution in the whole lake, only that monitoring stations were established where we could find sufficient tubers to monitor density over time.

Additionally, the response of the tuber bank should be similar at a whole lake scale since the whole lake was treated with similar doses of Sonar. Even though tuber distribution is not uniform, comparing changes in densities around these fixed stations should allow for relative comparison of attrition. Factors that may influence densities other than those resulting from management (including clumped distribution) likely would be identified over time as these stations are sampled more rigorously. Additional effort should be made to locate additional areas that contain tubers where hydrilla was previously identified, and fixed tuber sampling stations established at any new location where high tuber densities are located. Sampling should continue for a few years even after no tubers are found at these stations.

Tubers were found sprouting in September. Therefore, maintaining effective herbicide residue throughout the hydrilla growing season is critical. Herbicide residues need to be maintained well into September/October or until unfavorable water temperatures for hydrilla growth are determined (or ice cover). Otherwise, a plant could produce vegetative growth and possible fragment or form new tubers in as little as 30 days (Van 1989). In 2007, Sonar residues were maintained lethal to hydrilla sprouting from tubers into November.

A total of 328 eelgrass tubers were collected in the May 2007 survey, with 0 eelgrass tubers found in September 2007. Eelgrass tuber densities exceeded those of hydrilla pretreatment, but apparently do not have similar dormancy mechanisms or the longevity of hydrilla tubers. Eelgrass tuber densities will continue to be monitored. Eelgrass is relatively tolerant of Sonar A.S. applied to manage Eurasian watermilfoil at concentrations maintained between 2 to 6 ppb for 60 to 90 days. In fact, eelgrass becomes a nuisance species after Sonar application in many Michigan lakes treated at 6 ppb with a bump back to 6 ppb 14 to 21 days after the initial application. In Lake Manitou, the long exposure to Sonar above 4 ppb, exposure to relatively high concentrations in July (see section 4.0), application timing prior to eelgrass tuber sprouting, and the application of Sonar pellets in the littoral zone all likely contributed to greater impact on eelgrass than traditionally experienced with low rates of Sonar.

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2.3 Tier II Surveys

For reference: the initial Sonar treatment was conducted on May 18, 2007; the 2-acre site adjacent to the IDNR public access site was treated June 6; the bump Sonar treatment was conducted on June 27, 2007. Details of the treatments can be found in Section 4.0.

Tier II surveys were completed on May 31 and August 27. These surveys were included in the vegetation monitoring program to quantify species diversity and abundance, allow for pre- and post-treatment comparisons of the plant community, and locate additional areas of hydrilla. A total of 121 individual points in the littoral zone were selected for sampling using the Tier II method originally described in Donahoe and Keister (2005) (Figure 10).

The design of the Lake Manitou point-intercept survey was based on LARE recommendations. Although the Tier II LARE recommendation for an 809-acre lake is to sample 100 randomly selected points within specified depth ranges of the lake, a total of 121 locations were targeted for this plan. Of the 121 sites, seven were located within known hydrilla beds, one was a pre-existing bladderwort site, two were located below the dam, ten were selected by IDNR, and the remaining 101 sites were distributed as a grid within the October 2006 littoral zone according to Tier II depth ranges. The littoral zone was defined for this project using an October 2006 hydroacoustic survey of the lake by ReMetrix. The hydroacoustic data recorded the locations and depths at which submersed vegetation existed in the lake. The littoral zone was defined as the regions of the lake that supported submersed vegetation as of October 2006, and extended to depths of 20 feet. The 20-foot-depth contour line was also determined using hydroacoustic data from the October 2006 survey.

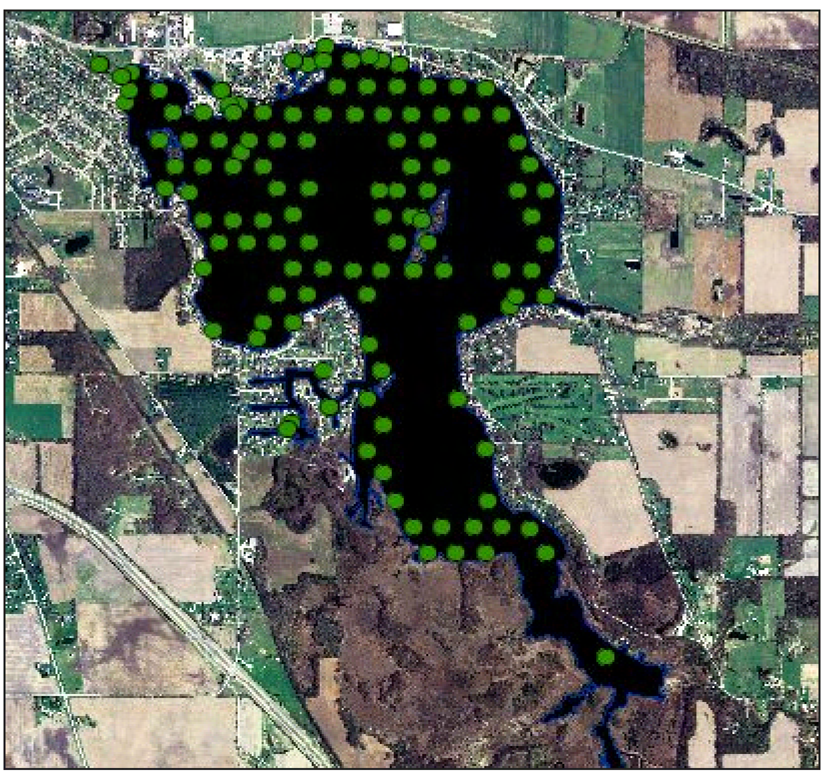

Figure 10. LARE Tier II vegetation target sample sites (121 sites).

2.3.1 Spring Tier II Survey Results

The spring survey was conducted on May 31. A total of 119 of the targeted 121 sites were sampled; two of the targeted sites were unable to be sampled on this sampling date. Aquatic vegetation was present at 92% of the sites. A total of 10 submersed plant species were collected; 7 native and 3 non-native. The maximum number of species per site was 4, the mean species per site was 1.58, and mean native species collected per site was 1.50. The overall diversity index was 0.76, and the native species diversity index was 0.73. Plant injury was also recorded during the Tier II survey using the ratings in Table 9. Table 10 outlines the results of the survey.

Table 9. Plant rating scales used during the Tier II surveys.

DENSITY RATINGS
0: No plants retrieved
1: 1-20% of rake teeth filled
3: 20-99% of rake teeth filled
5: 100%+ of rake teeth filled
8: Plant present but unranked

INJURY RATINGS
1: Healthy
2: Slight Injury
3: Moderate Injury
4: Severe Injury
5: Dead Plant

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Table 10. Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou, May 31, 2007.

Occurrence and abundance of submersed aquatic plants in Lake Manitou					
County:	Fulton	Sites with plants:	111	Mean species/site:	1.60
Date:	5/31/2007	Sites with native plants:	111	Standard error (ms/s):	0.0817166
Secchi (ft):	6	Number of species:	10	Mean native species/site:	1.52
Maximum plant depth (ft):	20	Number of native species:	7	Standard error (mns/s):	0.0761497
Trophic status	Mesotrophic	Maximum species/site:	4	Species diversity:	0.76
Total sites:	121			Native species diversity:	0.73

All depths (0 to 20 ft)	Frequency of	Rake score frequency per species				Plant Dominance
Species	Occurrence	0	1	3	5	
eel grass	60.3	39.7	58.7	1.7	0.0	12.4
common coontail	36.4	63.6	29.8	3.3	3.3	10.2
Chara	24.0	76.0	22.3	1.7	0.0	4.8
sago pondweed	20.7	79.3	17.4	3.3	0.0	4.8
Eurasian watermilfoil	5.0	95.0	4.1	0.8	0.0	1.0
flatstemmed pondweed	4.1	95.9	3.3	0.0	0.8	0.8
hydrilla	3.3	96.7	3.3	0.0	0.0	0.7
curlyleaf pondweed	3.3	96.7	2.5	0.8	0.0	0.7
large leaf pondweed	2.5	97.5	1.7	0.8	0.0	0.5
variable pondweed	0.8	99.2	0.0	0.8	0.0	0.2

Depth: 0 to 5 ft	Frequency of	Rake score frequency per species				Plant Dominance
Species	Occurrence	0	1	3	5	
eel grass	63.8	36.2	61.7	2.1	0.0	13.2
common coontail	34.0	66.0	27.7	3.2	3.2	9.8
Chara	25.5	74.5	24.5	1.1	0.0	5.1
sago pondweed	24.5	75.5	21.3	3.2	0.0	5.7
Eurasian watermilfoil	6.4	93.6	5.3	1.1	0.0	1.3
hydrilla	4.3	95.7	4.3	0.0	0.0	0.9
flatstemmed pondweed	4.3	95.7	3.2	0.0	1.1	0.9
large leaf pondweed	3.2	96.8	2.1	1.1	0.0	0.6
curlyleaf pondweed	2.1	97.9	2.1	0.0	0.0	0.4
variable pondweed	1.1	98.9	0.0	1.1	0.0	0.2

Depth 5 to 10 ft	Frequency of	Rake score frequency per species				Plant Dominance
Species	Occurrence	0	1	3	5	
eel grass	45.8	54.2	45.8	0.0	0.0	9.2
common coontail	41.7	58.3	33.3	4.2	4.2	11.7
Chara	20.8	79.2	16.7	4.2	0.0	4.2
curlyleaf pondweed	8.3	91.7	0.0	4.2	0.0	1.7
sago pondweed	8.3	91.7	4.2	4.2	0.0	1.7
flatstemmed pondweed	4.2	95.8	4.2	0.0	0.0	0.8

Depth: 10 to 15 ft	Frequency of	Rake score frequency per species				Plant Dominance
Species	Occurrence	0	1	3	5	
eel grass	100.0	0.0	100.0	0.0	0.0	20.0

Depth: 15 to 20 ft	Frequency of	Rake score frequency per species				Plant Dominance
Species	Occurrence	0	1	3	5	
common coontail	100.0	0.0	100.0	0.0	0.0	20.0
eel grass	50.0	50.0	50.0	0.0	0.0	10.0

Species Observed: Duckweed, Watermeal, Spatterdock, White water lily, bladderwort, pickerel weed
common cattail, bulrush

2007 treatment dates: May 18 (initial Sonar); June 6 (2-acre contact); June 27 (bump Sonar)

Eelgrass was present at the highest percentage of sample sites (60.3%) and has the highest dominance rating (Figure 11). Eelgrass was the most frequent and dominant species in all but the 15-20 foot depth range. Coontail ranked second in site frequency (36.4%), and was the only species collected in the 15-20 foot depth range (Figure 12). Sago pondweed ranked third in frequency (24.0%). Location and density of sago pondweed is reported in Figure 13. Eurasian watermilfoil was the most frequently occurring exotic species (5.0%) (Figure 14). Hydrilla and curlyleaf pondweed accounted for the remaining exotic species collected, both occurring at 3.3% of sample sites (Figures 15 and 16). Flat-stem pondweed, large-leaf pondweed, and variable-leaf pondweed all were present at less than 5% of sample sites.

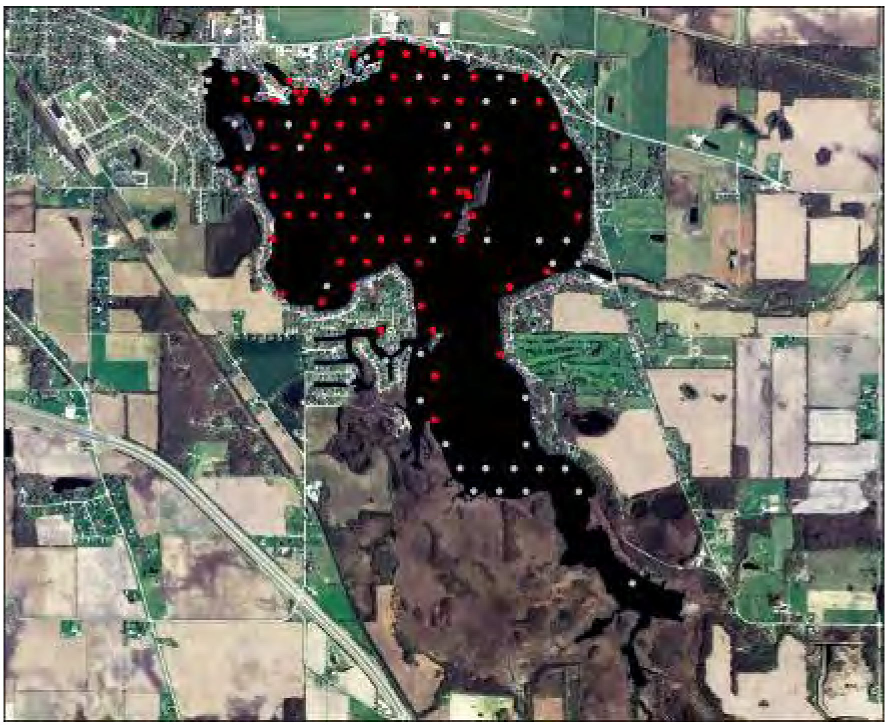

Figure 11. Eelgrass distribution, May 31, 2007.
Red points = plant was present. White points = plant was absent.
2007 treatment dates: May 18 (initial Sonar); June 6 (2-acre contact); June 27 (bump Sonar)

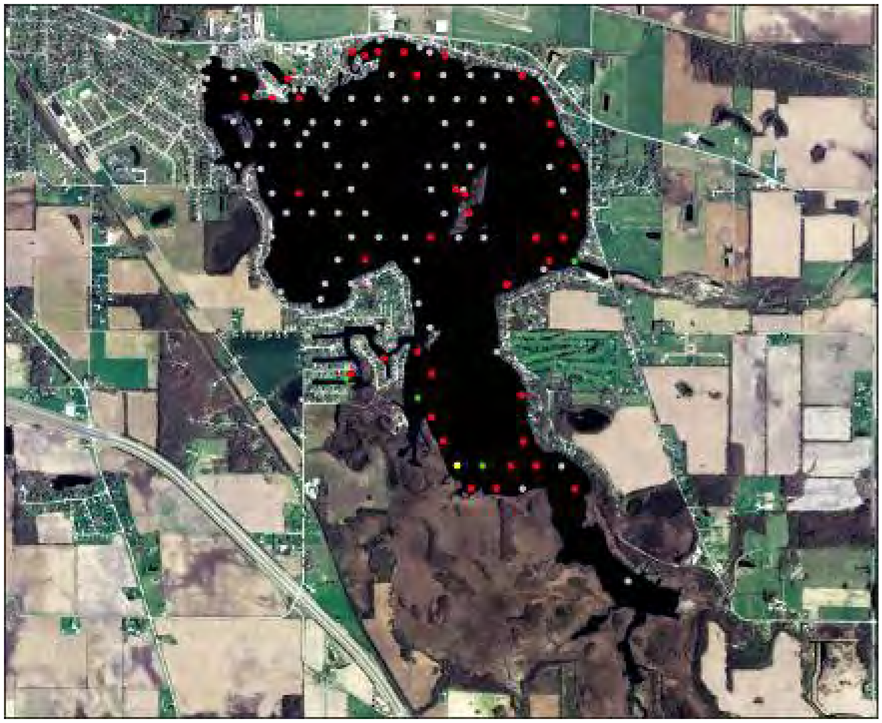

Figure 12. Common coontail distribution, May 31, 2007.
Red points = plant was present. White points = plant was absent.
2007 treatment dates: May 18 (initial Sonar); June 6 (2-acre contact); June 27 (bump Sonar)

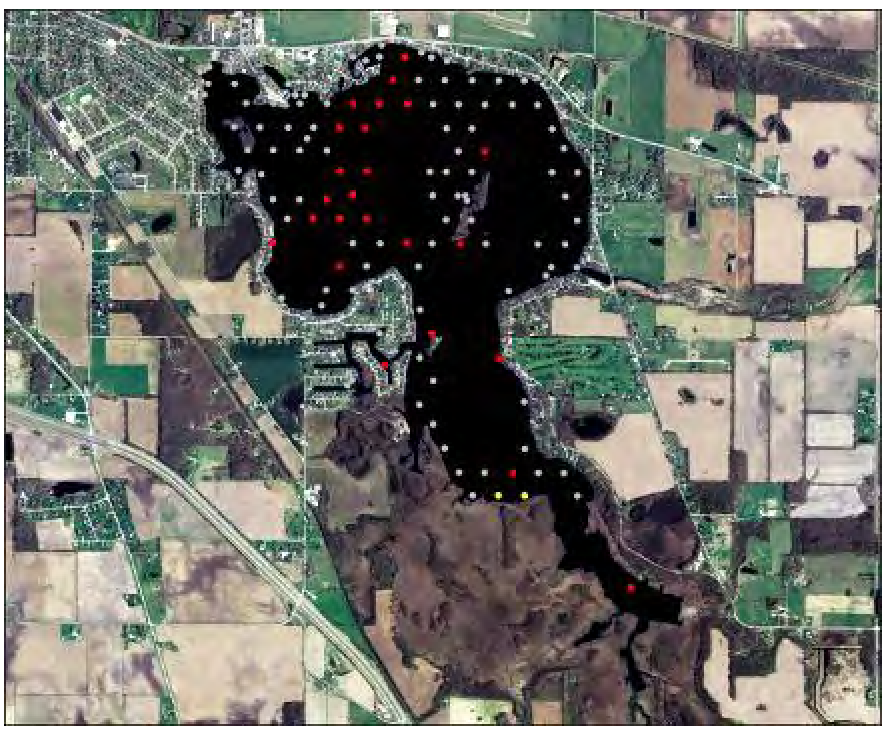

Figure 13. Sago pondweed distribution, May 31, 2007.
Red points = plant was present. White points = plant was absent.
2007 treatment dates: May 18 (initial Sonar); June 6 (2-acre contact); June 27 (bump Sonar)

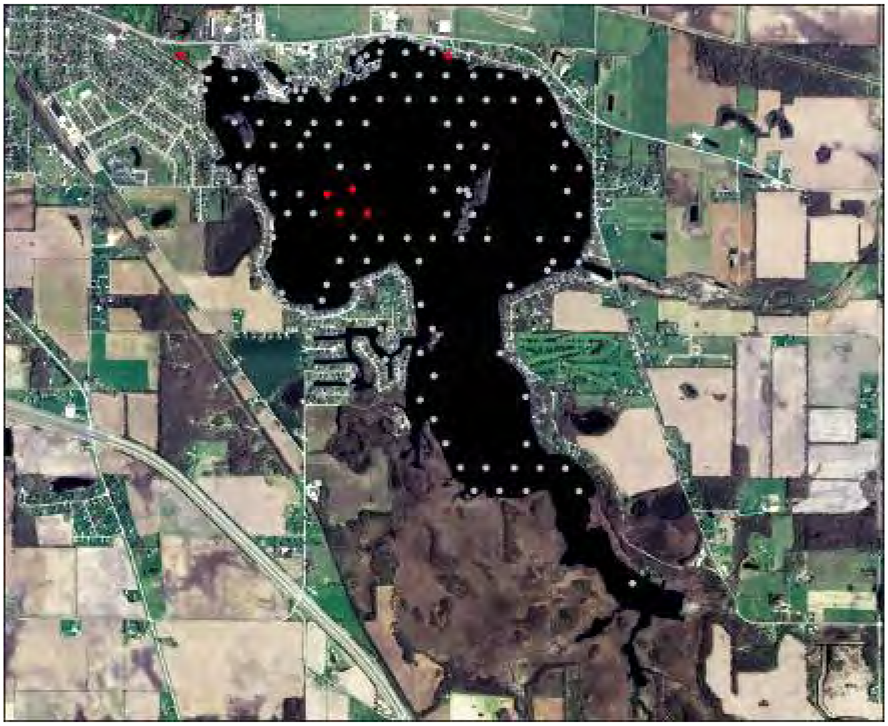

Figure 14. Eurasian watermilfoil distribution, May 31, 2007.
Red points = plant was present. White points = plant was absent.
2007 treatment dates: May 18 (initial Sonar); June 6 (2-acre contact); June 27 (bump Sonar)

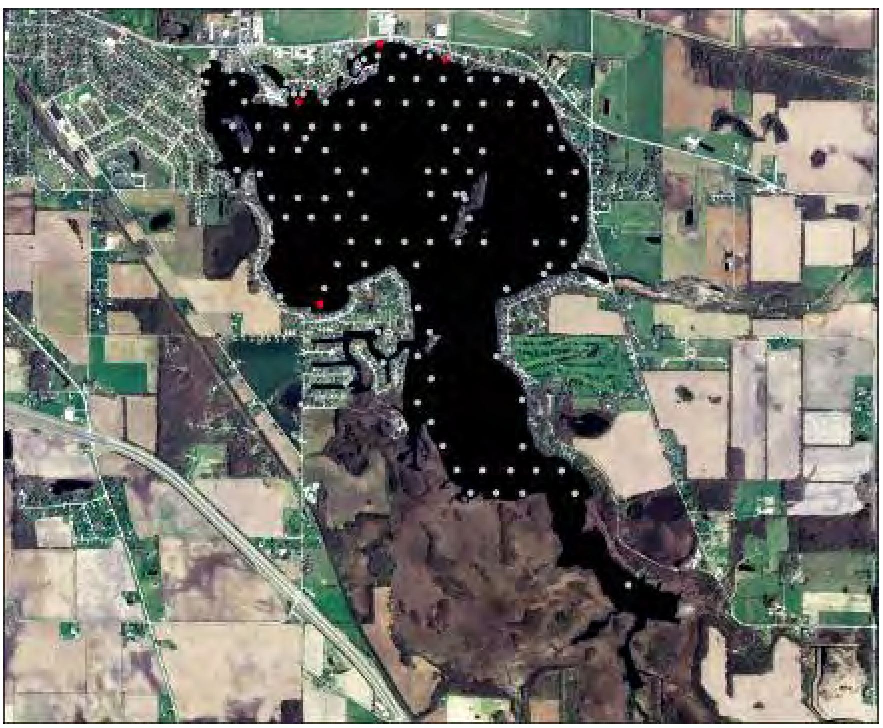

Figure 15. Hydrilla distribution, May 31, 2007.
Red points = plant was present. White points = plant was absent.
2007 treatment dates: May 18 (initial Sonar); June 6 (2-acre contact); June 27 (bump Sonar)

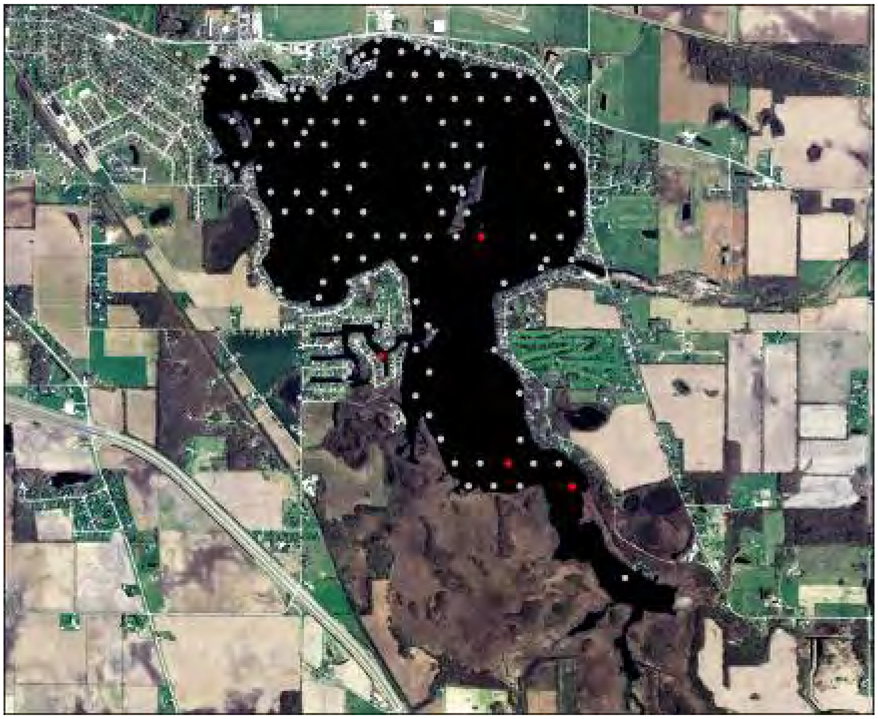

Figure 16. Curlyleaf pondweed distribution, May 31, 2007.
Red points = plant was present. White points = plant was absent.
2007 treatment dates: May 18 (initial Sonar); June 6 (2-acre contact); June 27 (bump Sonar)

2.3.2 Summer Tier II Survey Results

The same target sites and methods described in Section 2.3.1 were used again on August 27, 2007 (summer). A total of 111 of the 121 targeted sites were sampled; ten of the targeted sites were unable to be sampled on this sampling date. Results of the sampling are listed in Table 11. Plants were growing to a maximum depth of 7.0 feet. Aquatic vegetation was present at 47% of the sites. A total of 5 species were collected. The maximum number of species per site was 3, the mean species collected per site was 0.55, and the species diversity index was 0.46. No exotic species were collected.

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Table 11. Occurrence and Abundance of Submersed Aquatic Plants in Lake Manitou, August 27, 2007.

Occurrence and abundance of submersed aquatic plants in Lake Manitou						
County:	Fulton	Sites with plants:	57		Mean species/site:	0.55
Date:	8/27/2007	Sites with native plants:	57		Standard error (ms/s):	0.0586816
Secchi (ft):	4	Number of species:	5		Mean native species/site:	0.55
Maximum plant depth (ft):	7	Number of native species:	5		Standard error (mns/s):	0.0586816
Trophic status	Mesotrophic	Maximum species/site:	3		Species diversity:	0.46
Total sites:	121				Native species diversity:	0.46

All depths (0 to 10 ft)	Frequency of Occurrence	Rake score frequency per species				Plant Dominance
Species		0	1	3	5	
Chara	38.8	61.2	37.2	0.8	0.8	8.8
common coontail	7.4	92.6	7.4	0.0	0.0	1.5
eel grass	6.6	93.4	6.6	0.0	0.0	1.3
sago pondweed	0.8	99.2	0.8	0.0	0.0	0.2
common bladderwort	0.8	99.2	0.8	0.0	0.0	0.2

Depth: 0 to 5 ft	Frequency of Occurrence	Rake score frequency per species				Plant Dominance
Species		0	1	3	5	
Chara	45.7	54.3	43.6	1.1	1.1	10.4
common coontail	6.4	93.6	6.4	0.0	0.0	1.3
eel grass	6.4	93.6	6.4	0.0	0.0	1.3
sago pondweed	1.1	98.9	1.1	0.0	0.0	0.2
common bladderwort	1.1	98.9	1.1	0.0	0.0	0.2

Depth: 5 to 10 ft	Frequency of Occurrence	Rake score frequency per species				Plant Dominance
Species		0	1	3	5	
Chara	16.7	83.3	16.7	0.0	0.0	3.3
common coontail	12.5	87.5	12.5	0.0	0.0	2.5
eel grass	8.3	91.7	8.3	0.0	0.0	1.7

Depth: 10 to 15 ft	Frequency of Occurrence	Rake score frequency per species				Plant Dominance
Species		0	1	3	5	
No Plants Collected						

Depth: 15 to 20 ft	Frequency of Occurrence	Rake score frequency per species				Plant Dominance
Species		0	1	3	5	
No Plants Collected						
Species Observed: duckweed, watermeal, sprirodella, bulrush, spatterdock, water lily, pickeral weed						

2007 treatment dates: May 18 (initial Sonar); June 6 (2-acre contact); June 27 (bump Sonar)

Chara was present at the highest percentage of sample sites (38.8%) and also had the highest dominance rating (Figure 17). Coontail and eelgrass were both collected at 6.4% of sample sites (Figures 18 & 19). Sago pondweed and common bladderwort were only collected at 1 site in less than 5.0 feet of water.

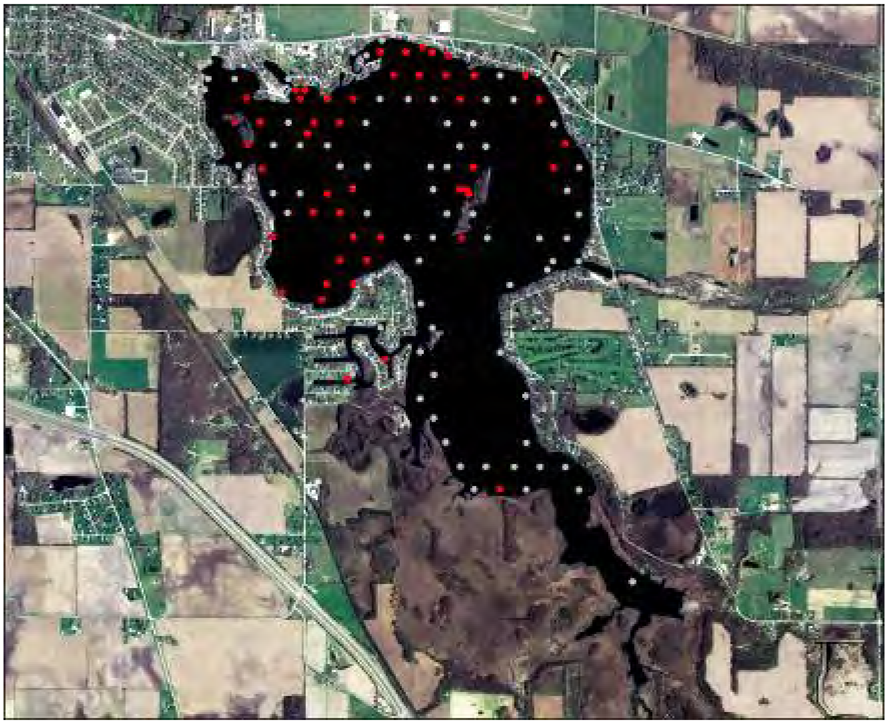

Figure 17. Chara distribution, August 27, 2007.
Red points = plant was present. White points = plant was absent.
2007 treatment dates: May 18 (initial Sonar); June 6 (2-acre contact); June 27 (bump Sonar)

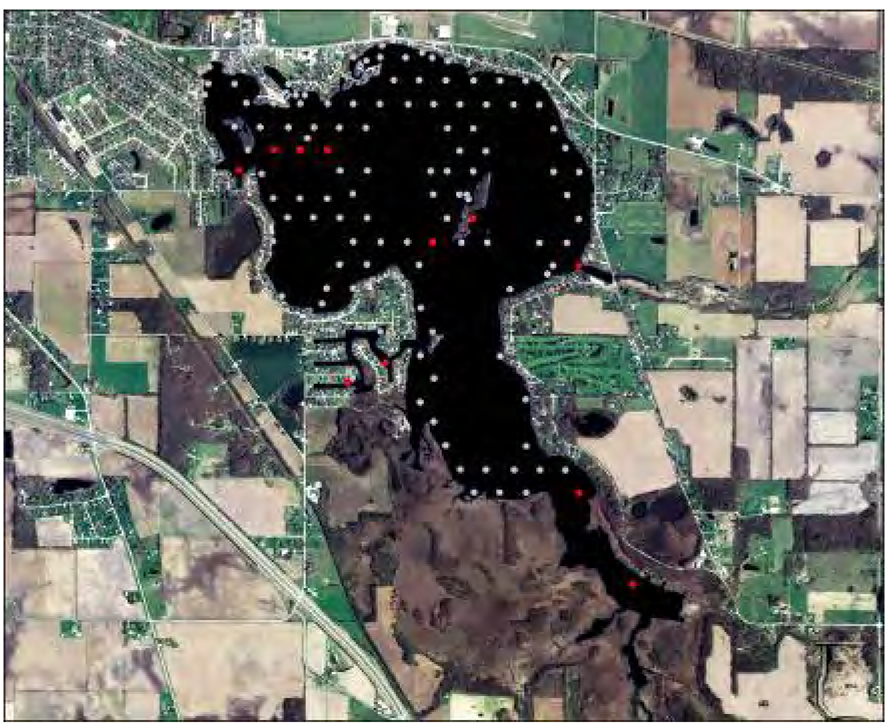

Figure 18. Common coontail distribution, August 27, 2007.
Red points = plant was present. White points = plant was absent.
2007 treatment dates: May 18 (initial Sonar); June 6 (2-acre contact); June 27 (bump Sonar)

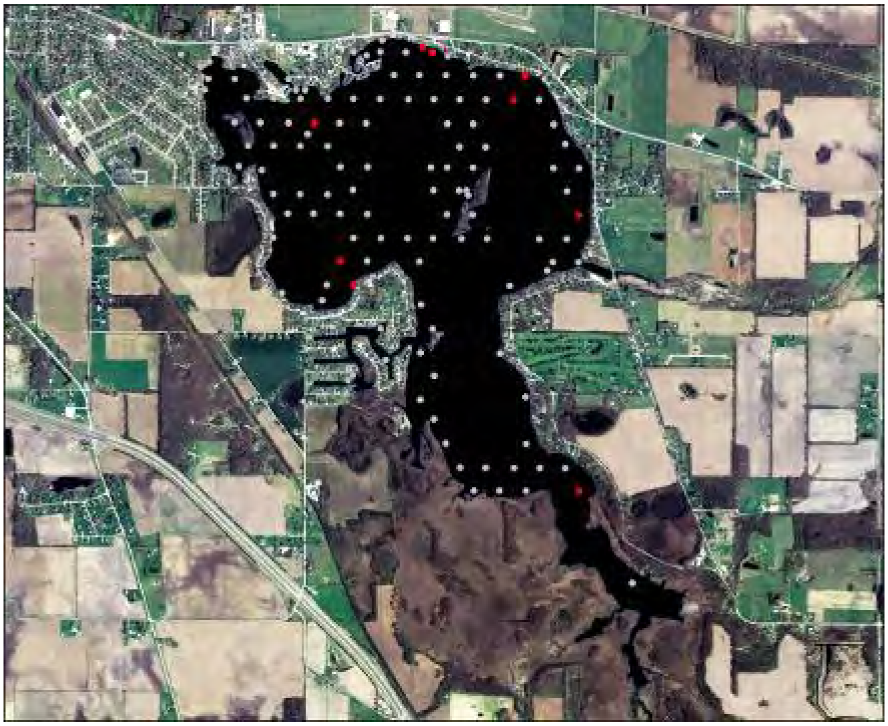

Figure 19. Eelgrass distribution, August 27, 2007.
Red points = plant was present. White points = plant was absent.
2007 treatment dates: May 18 (initial Sonar); June 6 (2-acre contact); June 27 (bump Sonar)

2.3.3 Tier II Survey Discussion

For reference: the initial Sonar treatment was conducted on May 18, 2007; the 2-acre site adjacent to the IDNR public access site was treated June 6; the bump Sonar treatment was conducted on June 27, 2007. Details of the treatments can be found in Section 4.0.

Annual Tier II surveys have been completed on Lake Manitou since 2004. Aquatic Weed Control, Inc. completed surveys in 2004, 2005 and 2006. The primary objective of this vegetation management plan is the eradication of hydrilla. Hydrilla was detected shortly after the initial Sonar application. No hydrilla was observed or collected during the August survey even at sites that were intentionally placed in areas where hydrilla was found in 2006. Before the introduction of hydrilla, Eurasian watermilfoil was the primary objective of vegetation management. Milfoil is highly susceptible to low doses of Sonar, and was not collected in the August survey. The Sonar treatment was also likely effective on curlyleaf pondweed, and the timing of the application would prevent new curlyleaf turions from being produced.

The hydrilla eradication treatment with Sonar was expected to damage some submersed native plant species (e.g. coontail, naiad). The treatment protocol called for relatively low levels of Sonar to be maintained for an extended period in order to control hydrilla biomass and plants sprouting from tubers. This effect on non-target vegetation was evident when comparing percent occurrence of individual species over the last five LARE surveys (Table 12, Chart 1, Figure 20). Eelgrass typically dominated the submersed fauna during the summer months, and in 2007 was reduced to 6.6%

occurrence. The Sonar treatments were not anticipated to have this level of impact on the eelgrass populations. However, due to factors mentioned previously, impact on eelgrass was greater than expected (section 2.2.4). Modifications to the future treatment program will be made attempting to improve selectivity on those species with moderate susceptibility to Sonar (i.e. eelgrass). Declines were also evident in sago pondweed and coontail. The impacts on coontail were expected, but sago pondweed had a larger decrease than traditionally observed when using Sonar at these concentrations. Sago is susceptible to Sonar, but generally at higher concentrations (i.e. 10 ppb) (Sprecher et al. 1998)

Naiad, flat-stem pondweed, large-leaf pondweed, variable-leaf pondweed, and Illinois pondweed were not detected post treatment at the 121 sample sites. These species had a relatively low abundance prior to treatment (generally <5%). Of these species, only Illinois pondweed was detected prior to 2007 treatments (2004, 2005, and 2006), but was absent from surveys May 2007. Flat-stem, large-leaf, and variable-leaf were not present August 2004, 2005 or 2006, and at frequencies less than 5% in May 2007 immediately following treatment. Increased sampling effort may be necessary to document changes in abundance of these species with small populations.

Chara was the only species with an increase in percent occurrence. This was likely due to Chara's high tolerance of Sonar. Chara abundance appears to have increased in areas once dominated by vascular plants. Bladderwort frequency did increase (<1%). Species with low abundance can be underestimated using point sampling methods. Therefore, we are not suggesting bladderwort increased or decreased in distribution.

The long exposure (>180 d) to Sonar concentrations greater than 4 ppb and exposure to concentrations of 8 to 12 ppb for short periods decreased the expected level of selectivity in this treatment. Likely the primary issue effecting selectivity occurred following the bump treatment (June 27th); exposures were maintained higher at that time than at any other time of the treatment and likely coincided with active growth periods for native plants. The first 40 days after treatment (early season), concentrations averaged 5.8 ppb (May 21 to June 26) with a maximum of 12.8 ppb. The last 96 days of the treatment (August 29 to November 13) concentrations averaged 4.6 ppb with a peak of 5.7 ppb. Sonar residues were maintained at 7.7 ppb the 44 days following the second treatment (July 12 to August 9) with maximum residue of 13.4 ppb. In the future, actions should be taken to reduce concentrations during late June through August to increase native plant selectivity. The concentrations were maintained higher than desired or expected due to drought conditions. In fact, it was estimated that 3 Sonar treatments would be necessary to maintain lethal concentrations throughout the growing season. The 2nd bump treatment was never conducted. In 2008, using lower doses with the possibility for more applications is recommended to avoid these relatively high concentrations in the middle of the growing season.

Table 12. Percent occurrence of species in Lake Manitou in the last five Tier II surveys.

Species	% of survey sites identified				
	Aug 2004	Aug 2005	Aug 2006	May 2007	Aug 2007
hydrilla (*Hydrilla verticillata*)				3.3%	
Eurasian watermilfoil (*Myriophyllum spicatum*)	27.5%	30.0%	2.9%	5.0%	
curlyleaf pondweed (*Potamogeton crispus*)				3.3%	
common coontail (*Ceratophyllum demersum*)	26.4%	11.0%	24.3%	36.4%	7.4%
Chara (*Chara spp.*)	12.1%	10.0%	10.0%	24.0%	38.8%
Naiad species (*Najas spp.*)	11.0%	23.0%			
Slender naiad (*Najas flexillis*)			8.6%		
sago pondweed (*Potamogeton pectinatus*)	14.3%	16.0%	10.0%	20.7%	0.8%
eelgrass (*Vallisneria americana*)	50.5%	61.0%	42.9%	60.3%	6.6%
flatstemmed pondweed (*Potamogeton zosteriformis*)				4.1%	
large leaf pondweed (*Potamogeton amplifolius*)				2.5%	
variable pondweed (*Potamogeton gramineus*)				0.8%	
common bladderwort (*Utricularia vulgaris*)					0.8%
Illinois pondweed (*Potamogeton illinoensis*)	1.1%	2.0%	5.7%		

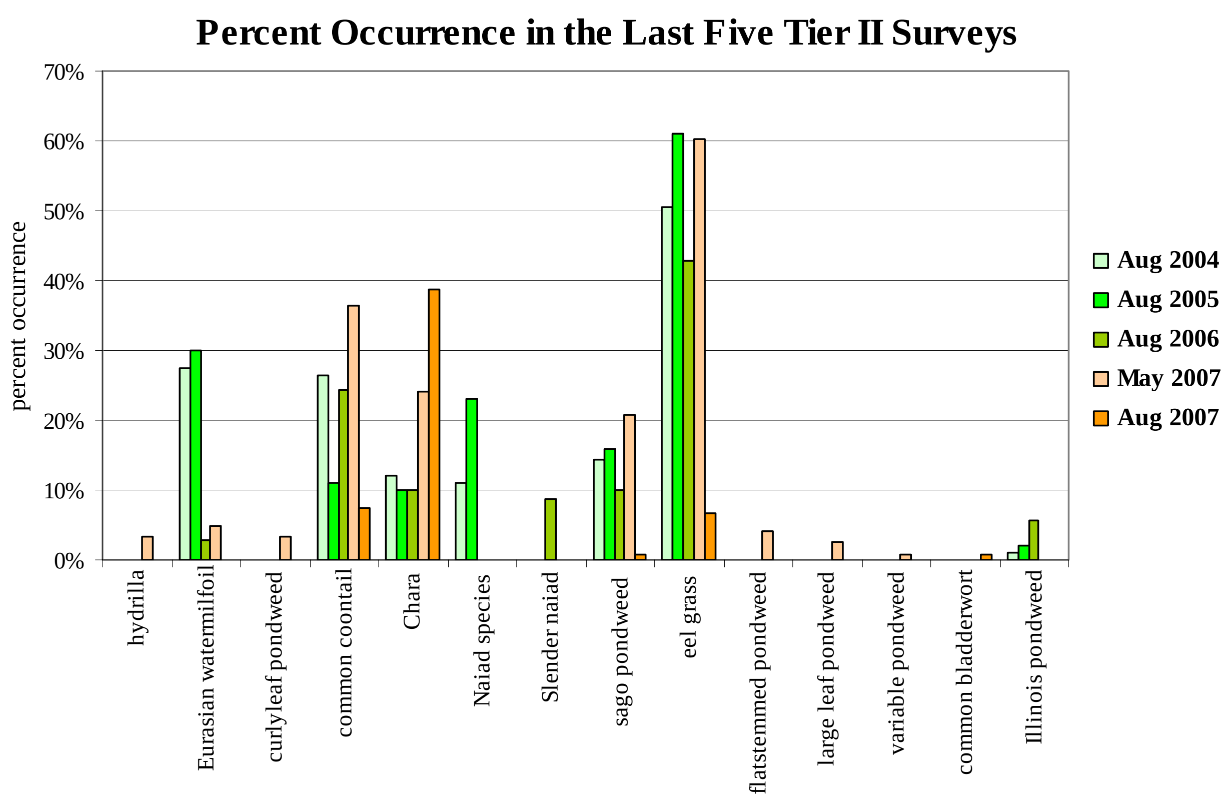

Chart 1. Percent occurrence of species in Lake Manitou in the last five Tier II surveys. *(Data are from Table 12.)*

Tier II surveys not only provide information on species response, they also provide data on lake-wide changes of submersed aquatic plant diversity and abundance. Table 13 and Chart 2 compare the number of sites sampled, the percentage of sites with vegetation, the native diversity index, and the number of native species collected in the last 5 surveys.

There is a decline in the percentage of sample sites with vegetation and the native diversity index when the August 2007 survey is compared to previous surveys.

Table 13. Comparison of number of sample sites, % of sites with vegetation, native diversity index, and number of native species collected in the last five Tier II surveys.

Survey Date	Number of Sample Sites	% of sites with vegetation	Native Diversity Index	Number of Native Species Collected
Aug 2004	95	83.5%	0.72	6
Aug 2005	100	79.0%	0.72	6
Aug 2006	70	56.0%	0.74	7
May 2007	119	92.0%	0.73	7
Aug 2007	111	47.0%	0.46	5

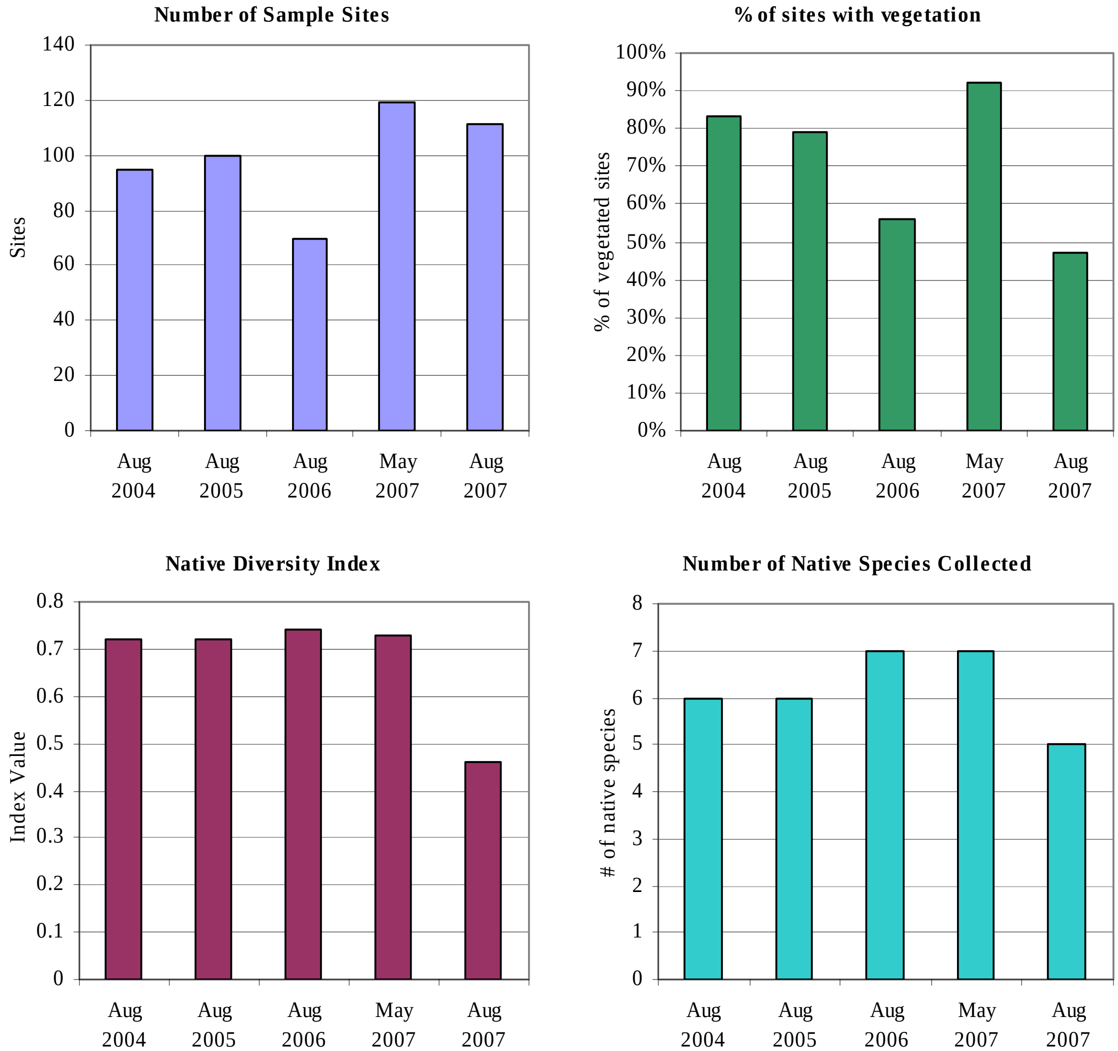

Chart 2. Comparison of number of sample sites, % of sites with vegetation, native diversity index, and number of native species collected in the last five Tier II surveys. *(Data are from Table 13.)*

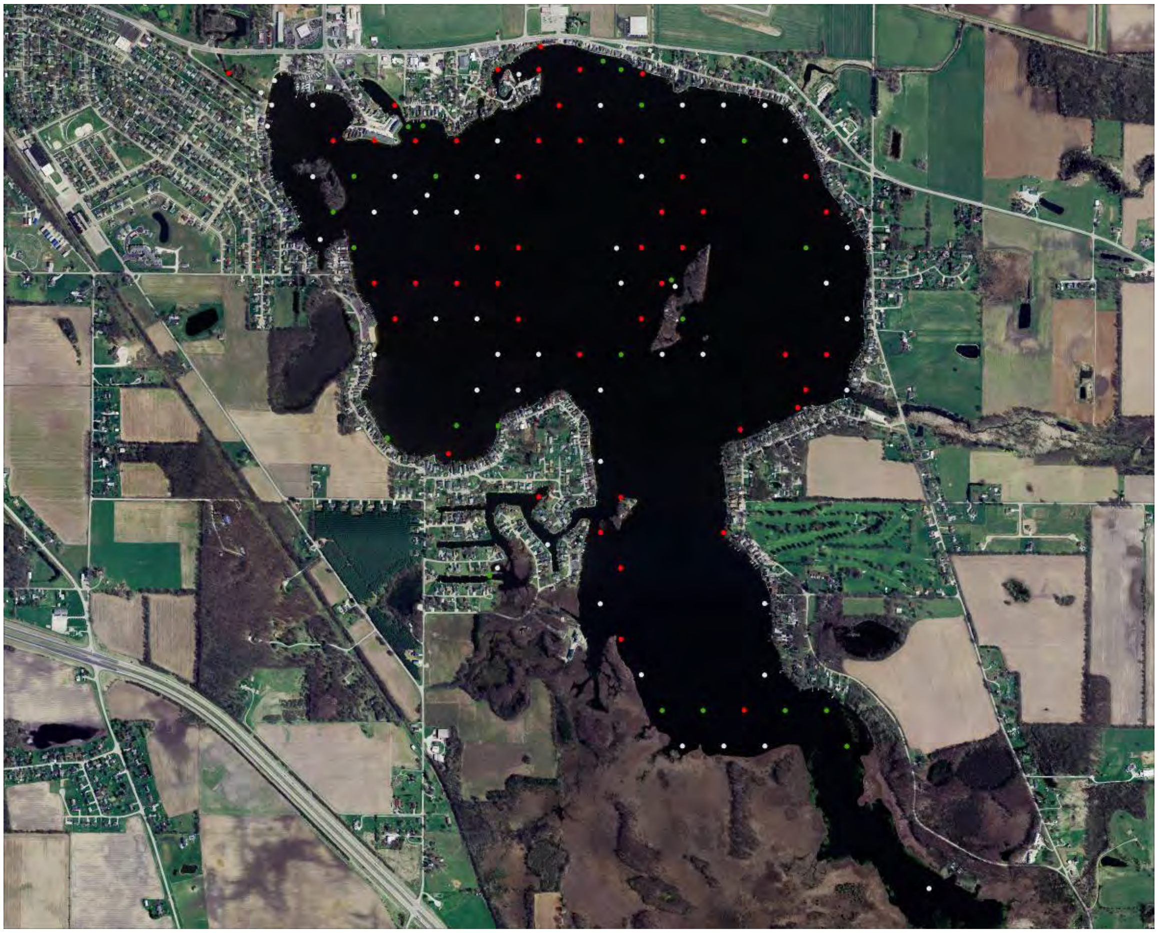

Figure 20. Lake-wide change in total species abundance, May 31, 2007 to August 27, 2007. Red points = a decrease in total species found at that site from May to August (e.g., from 4 species to 2, or from 1 to 0). White points = no change in total species. Green points = an increase in total species found.
2007 treatment dates: May 18 (initial Sonar); June 6 (2-acre contact); June 27 (bump Sonar)

The reduction in submersed vegetation decreased nuisance conditions created by several species, allowing for better access for lake users. However, the level of vegetation present in late summer is likely below levels desired by some fishermen. Assessing the positive or negative impacts on the fish population is beyond the scope of this plan. It may be beneficial for IDNR to complete a fish survey in 2009 in an attempt to assess any impacts to the fish population. Submersed vegetation metrics are expected to increase once the hydrilla eradication project is completed, and changes are being made to the application rates attempting to increase selectivity without jeopardizing the primary objective of hydrilla eradication.

2.4 Hydroacoustic Survey

2.4.1 Hydroacoustic Survey Protocol

ReMetrix completed a bathymetric analysis of Lake Manitou based on hydroacoustic data collected October 5, 2006. A grid of single-beam hydroacoustic depth points were collected across the lake, and data between transects were modeled to create contours and a bathymetric surface for the entire lake (Figure 21). A hypsographic curve of the lake is provided in Figure 22. The results of the bathymetric analysis were used to help plan details of the May 18, 2007 Sonar application. Accurate determinations of water volume could be calculated based on measured thermocline depth (Table 14) to ensure accurate Sonar treatments.

2.4.2 Hydroacoustic Survey Results

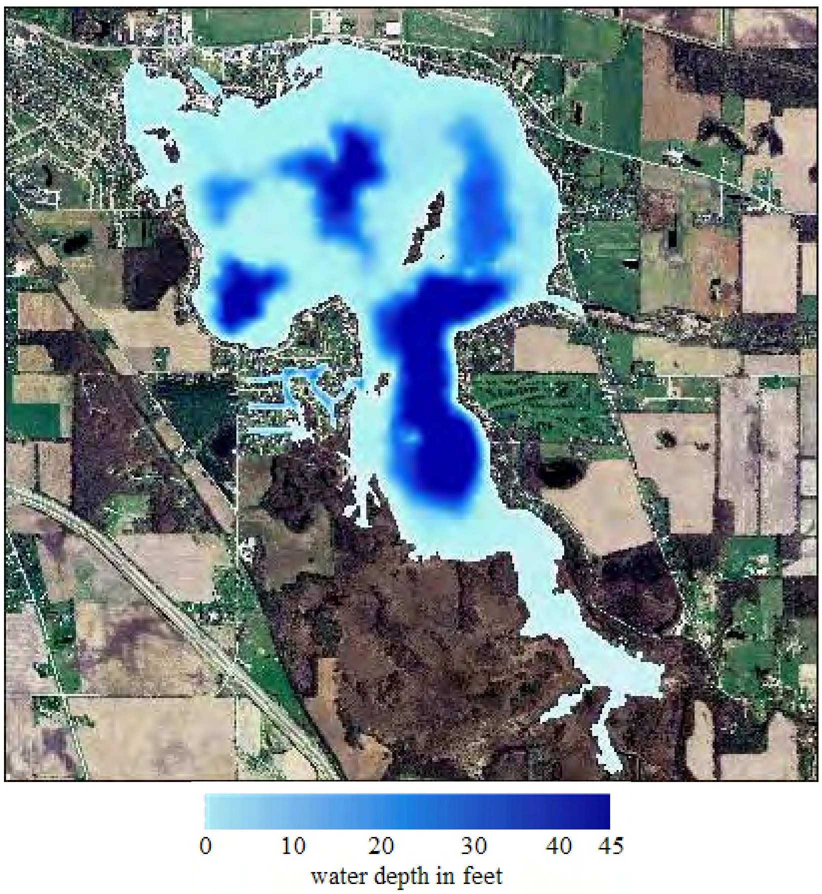

Figure 21. Bathymetric map used to help plan details of the Sonar treatment program.

Table 14. Water volume estimation calculations for Lake Manitou.

Mean Depth=	**10.67**	**Feet**	*Based on hydroacoustic data collected 10-5-06.*
Volume=	**8,631**	**Acre Feet**	

Interval	surface Sq. Feet	Surface Sq. Meters	Surface Acres	Acre Feet	Cumulative Acre Feet
Surface - 1 Foot	35,218,130	3,273,060	808	768	768
1 Foot-2 Foot	32,239,301	2,996,218	740	719	1,487
2 Foot-3 Foot	30,352,603	2,820,874	697	673	2,160
3 Foot-4 Foot	28,061,337	2,607,931	644	609	2,769
4 Foot-5 Foot	24,617,379	2,287,860	565	496	3,265
5 Foot-6 Foot	18,831,510	1,750,140	432	391	3,656
6 Foot-7 Foot	15,531,961	1,443,491	357	334	3,990
7 Foot- 8 Foot	13,861,464	1,288,240	318	307	4,297
8 Foot- 9 Foot	12,921,166	1,200,852	297	288	4,584
9 Foot- 10 Foot	12,195,884	1,133,446	280	273	4,857
10 Foot- 11 Foot	11,595,689	1,077,666	266	260	5,117
11 Foot- 12 Foot	11,054,571	1,027,376	254	248	5,365
12 Foot- 13 Foot	10,547,547	980,255	242	236	5,602
13 Foot- 14 Foot	10,046,290	933,670	231	225	5,827
14 Foot- 15 Foot	9,571,587	889,553	220	215	6,041
15 Foot- 16 Foot	9,117,734	847,373	209	204	6,245
16 Foot- 17 Foot	8,673,540	806,091	199	194	6,440
17 Foot- 18 Foot	8,243,914	766,163	189	184	6,624
18 Foot- 19 Foot	7,806,956	725,554	179	174	6,798
19 Foot- 20 Foot	7,378,911	685,772	169	164	6,962
20 Foot- 21 Foot	6,944,354	645,386	159	155	7,117
21 Foot- 22 Foot	6,536,350	607,467	150	145	7,262
22 Foot- 23 Foot	6,105,716	567,446	140	135	7,397
23 Foot- 24 Foot	5,614,187	521,765	129	124	7,522
24 Foot- 25 Foot	5,250,060	487,924	121	117	7,639
25 Foot- 26 Foot	4,963,399	461,282	114	111	7,750
26 Foot- 27 Foot	4,698,887	436,700	108	105	7,854
27 Foot- 28 Foot	4,426,688	411,402	102	98	7,953
28 Foot- 29 Foot	4,130,045	383,833	95	91	8,044
29 Foot- 30 Foot	3,838,730	356,759	88	85	8,129
30 Foot- 31 Foot	3,569,261	331,716	82	79	8,208
31 Foot- 32 Foot	3,298,454	306,548	76	73	8,280
32 Foot- 33 Foot	3,018,478	280,528	69	66	8,346
33 Foot-34 Foot	2,716,213	252,436	62	58	8,405
34 Foot-35 Foot	2,370,597	220,316	54	51	8,455
35 Foot-36 Foot	2,031,811	188,830	47	43	8,498
36 Foot-37 Foot	1,714,608	159,350	39	37	8,535
37 Foot-38 Foot	1,495,255	138,964	34	31	8,566
38 Foot-39 Foot	1,220,853	113,462	28	24	8,590
39 Foot-40 Foot	906,482	84,246	21	18	8,608
40 Foot-41 Foot	631,948	58,731	15	11	8,619
41 Foot-42 Foot	367,372	34,142	8	7	8,626
42 Foot-43 Foot	224,373	20,853	5	3	8,629
43 Foot-44 Foot	92,426	8,590	2	1	8,631
44 Foot-45 Foot	20,016	1,860	0	0	8,631

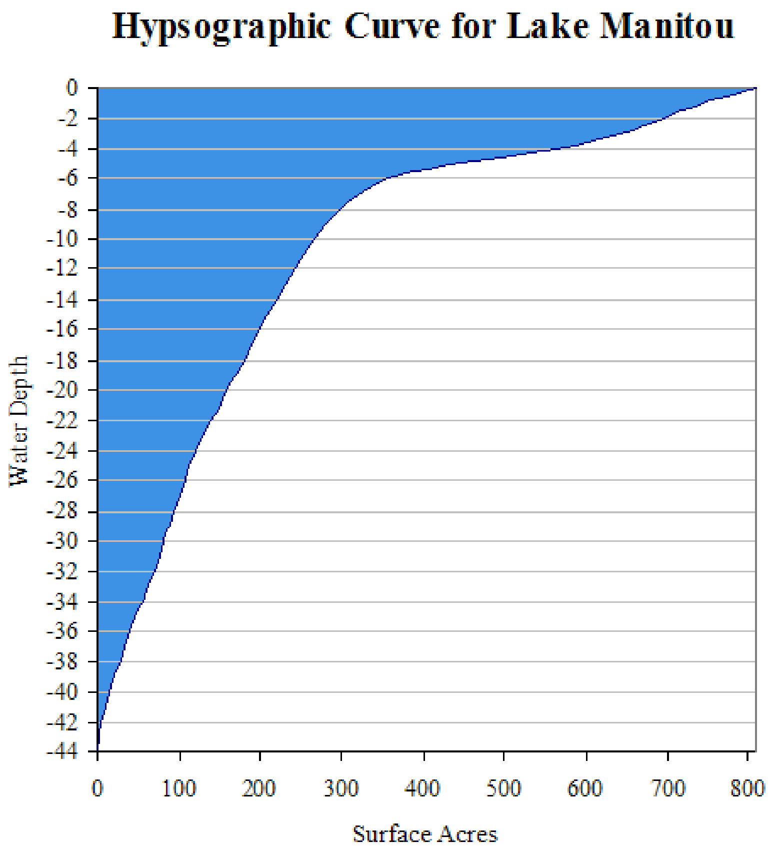

Figure 22. Hypsographic curve for Lake Manitou.

2.5 IDNR Surveys

In an effort to insure hydrilla was isolated to Lake Manitou, IDNR conducted several surveys in a 60-mile radius of the lake in 2007 (Table 15). A brief summary of these surveys is below:

- Canoe float and visual survey from Menominee public fishing area to Germany Bridge public access site on the Tippecanoe River in July 2007.
- 8 lakes had Tier 2 surveys conducted by fisheries biologists in the summer 2007
- 17 lakes had spot-checks performed by Doug Keller or fisheries biologists near access sites in 2007
- 42 lakes had LARE funded surveys conducted in 2007, and fisheries biologists also performed Tier 2 surveys on 6 of these lakes
- No hydrilla was detected at any locations (e-mail from Doug Keller, Aquatic Invasive Species Coordinator, IDNR).

Table 15. Water bodies within 60-mile radius of Lake Manitou sampled by IDNR for hydrilla in 2007.

WATER BODY	COUNTY	2007 PLANT SURVEY	WATER BODY	COUNTY	2007 PLANT SURVEY
Adam's Lake	LaGrange	LARE & DNR survey	Lawrence Lake	Marshall	DNR spot-check
Atwood Lake	LaGrange	LARE	Lilly Lake	LaPorte	LARE
Backwater Lake	Kosciusko	LARE	Little Barbee Lake	Kosciusko	LARE
Banning Lake	Kosciusko	LARE	Long Lake	Noble	DNR survey
Barr Lake	Fulton	DNR spot-check	Long Lake	Porter	LARE
Bass Lake	Starke	LARE	Loon Lake	Kosciusko	LARE
Beaver Dam Lake	Kosciusko	LARE	McClures Lake	Kosciusko	LARE
Big Barbee Lake	Kosciusko	LARE	Messick Lake	LaGrange	LARE & DNR survey
Big Lake	Noble	LARE & DNR survey	Mill Pond Lake	Marshall	DNR spot-check
Big Long Lake	LaGrange	LARE	Nyona Lake	Fulton	DNR spot-check
Blue Lake	Whitley	DNR survey	Oswego Lake	Kosciusko	LARE
Bruce Lake	Pulaski	LARE	Palestine Lake	Kosciusko	DNR spot-check
Caldwell Lake	Kosciusko	LARE	Palestine Lake	Kosciusko	LARE
Carr Lake	Kosciusko	DNR spot-check	Pine Lake	LaPorte	LARE
Center Lake	Kosciusko	LARE	Pine Lake	LaPorte	LARE
Chapman Lake	Kosciusko	DNR survey	Pleasant Lake	St. Joseph	LARE
Dallas Lake	LaGrange	LARE	Pretty Lake	LaGrange	LARE
Dewart Lake	Kosciusko	LARE & DNR survey	Riddles Lake	St. Joseph	LARE
Diamond Lake	Kosciusko	LARE	Ridinger Lake	Kosciusko	LARE
Dixon Lake	Marshall	DNR spot-check	Round Lake	Whitley	DNR survey
Fish Lake	LaPorte	LARE	Sawmill Lake	Kosciusko	LARE
Fletcher Lake	Fulton	DNR spot-check	Sechrist Lake	Kosciusko	LARE
Grassy Creek Lake	Kosciusko	LARE	Shipshewana Lake	LaGrange	LARE
Hackenberg Lake	LaGrange	LARE	Shriner Lake	Whitley	DNR spot-check
Harris Lake	LaPorte	LARE	Silver Lake	Kosciusko	LARE
Hill Lake	Kosciusko	LARE	Simonton Lake	Elkhart	DNR survey
Hominy Ridge Lake	Wabash	DNR survey	Smalley Lake	Noble	DNR survey
Irish Lake	Kosciusko	LARE	South Mud Lake	Fulton	DNR spot-check
J. Edward Roush Lake	Huntington	DNR spot-check	Stone Lake	LaPorte	LARE
James Lake	Kosciusko	LARE	Sylvan Lake	Noble	LARE
Koontz Lake	Marshall	DNR spot-check	Tippecanoe River (Menominee to Germany Bridge)	Fulton	DNR spot-check
Kuhn Lake	Kosciusko	LARE	Webster Lake	Kosciusko	LARE
Lake Freeman	Carroll	DNR spot-check	Westler Lake	LaGrange	LARE
Lake Maxinkuckee	Marshall	DNR survey	Winona Lake	Kosciusko	LARE
Lake of the Woods	Marshall	LARE & DNR survey	Witmer Lake	LaGrange	LARE & DNR survey
Lake Shafer	White	DNR spot-check	Worster Lake	St. Joseph	DNR spot-check
Lake Tippecanoe	Kosciusko	LARE	Yellow Creek Lake	Kosciusko	LARE

3.0 2007 WATER QUALITY MONITORING

Basic water quality monitoring was included in the management plan to document these parameters throughout the treatment season. This data will be compared year to year throughout the hydrilla eradication project to detect and document any impact on water quality.

Water samples were collected at 1 foot depth from FasTEST sites denoted 2 and 7 on June 1, July 26, August 23, and October 17. Water samples were analyzed by GEI Consultants, Littleton, Colorado. This laboratory was utilized due to their low detection limits on phosphorous and nitrogen nutrients (2 µg/L - parts per billion). Chlorophyll detection limits were 0.0001 mg/L (0.1 mg/cubic meter). Water quality parameter assessment included: water temperature and dissolved oxygen profiles, Secchi depth, pH, conductivity, total and orthophosporus, total nitrogen, and nitrate/nitrite.

In addition to the periodic water quality sampling, dissolved oxygen and temperature profiles were recorded at FasTEST sample sites 2 and 7 on May 15, June 15 & 26, July 7 & 26, August 9 & 23, September 18, October 17, and November 13 (Table 16). These data were used to monitor thermocline depths for calculating Sonar bump treatments. The thermocline depth is important in calculating Sonar application rates and placement of Sonar pellets. Sonar will not mix below the thermocline, and slight thermal stratification can inhibit mixing into deeper waters. A thermocline defines a narrow, horizontal stratification boundary between cooler, deeper water and warmer, shallow water. Technically, it is defined as a $1^{o}C$ temperature change over a depth of 1 meter. Each stratification zone has a discreet water volume that can be calculated and used to more precisely calibrate treatment rates (Table 14).

Secchi transparency readings were taken throughout the 2007 season (Table 17). Secchi measurements ranged from a maximum of 9.0 feet on May 17 to a low of 2.6 feet on August 23. There appears to be no difference in the 2007 Secchi depths when compared to data collected by the Indiana Volunteer Lake Monitors (Table 18). From May to November, the average secchi depth was 4.5 feet in 2007.

<continued on next page...>

Table 16. Lake Manitou, Temperature and Dissolved Oxygen Profiles.

Temperature and Dissolved Oxygen Depth Profile (2007)

Temperature and Dissolved Oxygen Depth Profiles

	DAT -->	5/21/2007 4		6/15/2007 29		6/26/2007 40		7/12/2007 15		7/26/2007 29		8/9/2007 43		8/23/2007 57		9/18/2007 83		10/17/2007 112		11/13/2007 139	
	Depth (m)	Temp	D O_2	Temp	D O_2	Temp	D O_2	Temp	D O_2	Temp	D O_2	Temp	D O_2	Temp	D O_2	Temp	D O_2	Temp	D O_2	Temp	D O_2
Site 2	0	66.0	8.2	82.9	9.13	78.9	7.67	78.8	7.27	76.8	8.16	84.50	8.22	77.00	8.11	70.20	7.76	62.80	8.22	48.7	11.02
	1	65.7	8.22	80.9	9.45	78.9	7.70	78.8	7.31	76.8	8.09	84.40	8.18	76.90	8.11	69.20	7.83	62.50	8.20	48.4	11.09
	2	65.5	8.19	79.9	9.14	77.2	6.71	78.7	7.30	76.8	7.97	83.80	7.73	76.80	8.09	68.60	7.86	62.20	8.15	48.0	10.82
	3	65.2	8.14	76.0	5.00	74.5	5.68	78.5	7.20	76.7	7.75	82.20	6.63	74.20	7.07	68.20	7.86	62.10	8.44	47.7	10.60
	4	63.5	7.27	72.3	3.05	73.4	4.05	78.3	7.20	74.6	4.53	77.90	1.35	73.50	6.15	67.60	7.43	62.00	8.29	47.8	10.52
	5	62.0	6.77	68.4	1.39	71.2	2.19	71.3	0.20	72.8	2.34	74.50	0.14	73.30	5.50	67.40	7.23	62.00	8.30	47.7	10.41
	6	60.8	5.98	62.6	0.45	65.7	0.13	66.1	0.13	68.9	0.15	69.50	0.10	70.20	0.48	67.00	6.65	61.60	5.73	47.4	10.15
	7	57.4	3.49	58.4	0.09	61.8	0.09	61.5	0.09	62.7	0.09	64.50	0.07	66.00	0.11	66.00	3.27	61.20	4.59	47.3	10.17
	8	53.7	2.13	55.5	0.06	56.8	0.06	57.5	0.07	57.5	0.06	60.50	0.04	61.20	0.06	66.40	0.14	61.00	3.58	47.2	10.03
	9	50.8	0.77	53.6	0.05	53.7	0.04	54.0	0.06	54.1	0.04	54.50	0.02	56.90	0.04	66.50	0.11	60.30	1.10	47.1	9.98
	10	47.0	0.09	50.2	0.03	51.1	0.03	51.8	0.05	52.2	0.03	53.70	0.01	53.70	0.03	66.50	0.09	54.70	0.15	47.1	9.86
Site 7	0	69.5	8.65	82.0	11.42	79.2	8.06	79.3	7.57	77.4	8.68	85.70	8.00	79.00	8.25	71.10	7.88	63.40	7.40	49.0	10.87
	1	69.5	8.34	81.2	11.52	79.0	8.11	79.4	7.53	77.3	8.71	85.70	8.01	78.80	8.28	70.20	7.87	63.20	7.35	48.5	10.83
	2	68.2	8.34	80.1	10.94	76.4	5.49	79.4	7.45	77.1	8.45	84.70	8.00	78.20	8.17	69.20	7.75	63.00	7.35	48.3	10.65
	3	66.8	8.37	77.1	6.53	75.5	5.03	79.3	7.34	76.6	7.08	83.20	6.87	77.90	7.85	68.80	7.58	62.90	7.36	48.1	10.31
	4	66.3	8.21	75.7	4.99	74.7	4.07	78.7	6.39	75.4	7.03	80.70	2.99	75.30	5.23	68.30	6.99	62.70	7.36	48.0	10.18
	5	65.3	7.62	73.6	3.41	74.0	2.85	77.4	4.38	74.9	3.26	78.50	0.41	74.40	4.14	68.20	7.13	62.60	7.10	48.0	10.15
	6	62.8	6.3	71.1	2.03	72.6	1.35	77.0	2.81	73.8	1.58	75.40	0.11	73.40	2.66	67.90	6.75	62.50	6.54	47.9	10.15
	7	60.9	5.39	65.7	0.57	66.1	0.11	68.9	0.14	71	0.12	71.80	0.08	72.50	1.29	67.60	6.19	62.40	6.24	47.9	10.16
	8	56.7	3.67	60.1	0.14	62.1	0.07	64.4	0.09	65.7	0.08	67.10	0.05	66.50	0.11	66.80	3.36	63.30	6.21	47.8	10.05
	9	50.9	2.61	56.1	0.08	57.2	0.05	58.2	0.06	59.8	0.05	60.70	0.03	60.90	0.07	64.10	0.20	61.90	3.52	47.7	10.00
	10	48.7	1.83	51.7	0.05	53.4	0.03	54.3	0.04	54.9	0.03	55.30	0.01	57.70	0.04	57.70	0.12	61.00	0.18	47.4	9.69
	11	47.5	0.73	49.3	0.04	50.4	0.02	51.3	0.03	52.9	0.02	53.10	0.01	54.60	0.04	54.20	0.08	58.30	0.13	47.4	9.54
	12	46.6	0.09	47.9	0.04	49.0	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-

__________ implies a strong indication of development of a thermocline

2007 treatment dates: May 18 (initial Sonar); June 6 (2-acre contact); June 27 (bump Sonar)

Table 17. Secchi depths recorded on Lake Manitou, May 2007 to November 2007.

Site	5/21/2007	6/15/2007	6/26/2007	7/12/2007	7/26/2007	8/9/2007	8/23/2007	9/18/2007	10/17/2007	11/13/2007
1	6.0	5.8	4.8	4.5	3.9	3.2	3.6	4.0	4.9	4.2
2	9.0	4.8	4.7	5.3	3.6	3.9	3.2	3.1	5.1	3.9
3	bv (5 ft)	bv (5 ft)	4.9	5.0	3.9	3.9	3.1	3.0	4.0	4.1
4	bv (5 ft)	2.9	2.6	4.2	3.2	3.1	2.6	3.2	4.5	3.9
5	7.0	5.0	5.5	4.5	4.6	3.5	3.9	4.0	5.2	4.1
6	bv (4 ft)	3.0	3.5	3.9	4.1	3.1	3.3	4.3	Bv (4 ft)	3.8
7	7.5	3.9	5.2	4.8	4.3	3.9	4.2	3.7	6.1	4.1
8	8.0	4.5	4.7	5.1	4.2	3.8	3.9	3.4	5.3	4.9
MEAN	**7.5**	**4.3**	**4.5**	**4.7**	**4.0**	**3.6**	**3.5**	**3.6**	**5.0**	**4.1**

"bv (x ft)" means the lake bottom was visible at the water depth in parentheses.
Site locations can be seen in Figures 4 or 29.

Table 18. Secchi depths recorded on Lake Manitou 1999-2007 (1999 to 2004 from Fascher & Jones 2006).

Year	Minimum	Maximum	Jul-Aug Mean	Observations
1999	2.8	5.4	3.1	10
2000	2.6	6.3	3.2	11
2001	2.5	5.5	3.7	13
2002	2.5	7.2	3.8	15
2003	2.5	10.4	3.3	14
2004	2.7	4.1	3.3	12
2007*	2.6	9.0	3.9	80

*2007 data are by authors of this report and are added for comparison with historical data.

Table 19 is a summary of the water quality monitoring results. Water quality samples were collected at FasTEST sample stations 2 and 7. The analytical laboratory labeled the results “sample 1” and “sample 2,” and it remains unclear whether sample 1 correlates to sample site 2 or 7. For this reason, the lab’s nomenclature was used in Table 19.

Table 19. Water quality data collected from Lake Manitou in 2007.

Sample Date & (Sample #)	Total P (µg/L)	Ortho P (µg/L)	Total N (µg/L)	Nitrate/Nitrite (µg/L)	Conductivity (µS)	Chlorophyll a (mg/L)
June 1 (1)	20	<2	1769	1038	415	0.0055
June 1 (2)	22	<2	1767	1027	406	0.0077
July 26 (1)	24	3	897	14	452	0.0038
July 26 (2)	37	3	1064	15	453	0.0044
August 23 (1)	22	4	870	11	432	0.0127
August 23 (2)	15	3	785	10	439	0.0124
October 17 (1)	27	5	812	13	409	0.0086
October 17 (2)	27	5	814	14	412	0.0112
November 13 (1)	36	<2	1008	NR	429	NR
November 13 (2)	37	<2	1138	NR	427	NR

2007 treatment dates: May 18 (initial Sonar); June 6 (2-acre contact); June 27 (bump Sonar)

No historical orthophosphorus, nitrogen, or conductivity measurements were found to compare these results to, but total phosphorus and chlorophyll a readings were collected from 1999-2004 by the Indiana Volunteer Lake Monitors. A comparison of the data indicates little change in these metrics following the Sonar treatment. These data are summarized below in Table 20. Chlorophyll *a* levels peaked August 23, 2007 but were within historical ranges. The Sonar treatment did not appear to have a deleterious effect on chlorophyll *a* ranges or effect intra-lake nutrient release. Total P ranged from 15 to 37 ppb, and Ortho P was maximal at 5 ppb on October 17th. Total nitrogen, nitrate and nitrites fluctuated throughout 2007, but without historical data no definitive conclusions can be made on the effect the Sonar treatment had on these parameters.

Table 20. Total phosphorus and chlorophyll *a* measurements collected from Lake Manitou, 1999-2007 (1999 to 2004 from Fascher & Jones 2006).

Year	Minimum Total P (µg/L)	Maximum Total P (µg/L)	Minimum Chl *a* (mg/L)	Maximum Chl *a* (mg/L)
1999	47.0	63.0	0.0048	0.0174
2000	58.0	71.0	0.0097	0.0189
2001	1.8	10.3	0.0350	0.0660
2002	0.0	7.1	0.0240	0.0770
2003	2.5	10.4	0.0200	0.0370
2004	12.3	15.9	0.0310	0.0660
2007*	15.0	37.0	0.0038	0.0127

Chl *a* units originally expressed as µg/L in Fascher & Jones, 2006.
*2007 data are by authors of this report and are added for comparison with historical data.

The Sonar treatment had an insignificant effect on secchi depths and other water quality parameters compared, even though cumulative plant cover was reduced compared to previous years. These data indicate that there has been little change in the water quality metrics sampled. The original objective of sampling water quality was to compare data within the years of the hydrilla eradication project. A reduced water quality sampling protocol will be used in 2008 upon request of IDNR. Water quality sample collection will be reduced to one station and analysis will involve only chlorophyll a, total and orthophosphorus. Sampling events will be reduced to three scheduled in conjunction with FasTEST sample collection in May, July, and September.

The 2008 results will be compared to 2007 data to continue monitoring for any gross changes in the selected water quality metrics as the hydrilla eradication project continues.

4.0 2007 VEGETATION CONTROL

The eradication of hydrilla was the primary objective of this Lake Manitou Aquatic Vegetation Management Plan. Due to the extensive reproductive capability of monoecious hydrilla through fragmentation, turions, and tubers, an aggressive prescription using the systemic herbicide Sonar was selected for the eradication project. Similar approaches have been taken in the States of Washington, Massachusetts, Maine, and California.

The initial lack of flow data for Lake Manitou resulted in the preparation of a treatment protocol based on static water conditions, with inclusion of additional "bump" treatments to sustain a Sonar residual in the lake for a period of 180 days at a lethal dose for hydrilla. Subsequent water flow data provided by the Indiana Department of Water indicated relatively long retention times, with a long-term (18-year) average of ~50% volume turnover from the period of April to September. This period would coincide with chemical control operations. However, large rain events cause the retention time to be much shorter (<30 days). Therefore, maintenance of an effective dose of Sonar for hydrilla required regularly scheduled monitoring of Sonar residue and periodic "bump" treatments as necessary.

SePRO collected hydrilla samples from Lake Manitou and conducted a PlanTEST at the SePRO Research and Technology Campus (SRTC) in Whitakers N.C. The PlanTEST is a proprietary test developed by SePRO Corporation that uses key biochemical parameters (Sprecher et al. 1998) to determine the plants inherent susceptibility to Sonar. The test was used to direct Sonar treatment recommendations by providing an indication of concentrations necessary for control. Plants were collected from Lake Manitou in September 2006 to conduct preliminary PlanTEST. The hydrilla in Lake Manitou responded favorably to Sonar under laboratory conditions (Chart 3 and Figure 23). SePRO's recommended treatment protocol was based on results of the initial/preliminary PlanTEST, extensive experience in hydrilla control throughout the U.S., and proprietary modeling of Sonar dissipation from various formulations.

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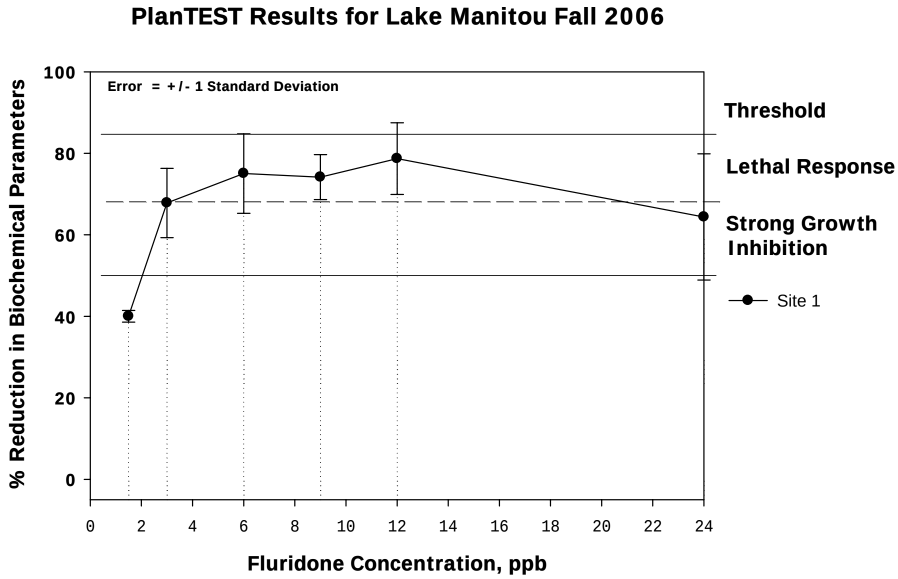


Chart 3. PlanTEST Results for Lake Manitou, Fall 2006.

Figure 23. Lake Manitou hydrilla susceptibility to Sonar (PlanTEST).

Initially, the treatment prescription recommended for Lake Manitou was a minimum three year program, followed by comprehensive analysis of collected data and recommendations for either extension of this program or alternative management procedures to achieve eradication of hydrilla. Each year, relatively long exposure time to Sonar will be necessary to control the standing crop of hydrilla, prevent production of new tubers, and to control biomass sprouting from existing tubers.

4.1 Sonar Application

The initial Sonar application was completed on May 18, 2007 by Aquatic Control, Inc., with SePRO Corporation and ReMetrix personnel on site for technical assistance. The lake was posted with signage for public notification prior to Sonar application (Figure 24). Sonar AS was applied at a concentration of 6.4 ppb along with granular Sonar Q at a concentration of 4.0 ppb. Dosing was based on the thermocline depth of 17-feet (5.2

meters) at the time of application (Table 21). Therefore, a total of 6,440 ac ft was treated at these concentrations (the whole lake volume is 8,631 ac ft). Sonar AS was applied with a custom built Carolina Skiff, 19 foot fiberglass boat equipped with a 90hp engine. The boat was equipped with a custom built herbicide application unit designed for accurate application of low dose Sonar AS. Travel routes and rates were pre-determined using information generated by a one-foot bathymetric contour survey and water volume table provided by ReMetrix LLC. The actual Sonar AS application travel route is illustrated in Figure 25. Sonar Q was applied to the littoral zone with a similar 19 ft Carolina Skiff and a 16 foot aluminum hull airboat. A custom built herbicide blower was used in the application of the pellets along predetermined travel routes. Sonar Q application routes are illustrated in Figure 26.

Table 21. Water temperature and dissolved oxygen profiles at FasTEST stations 2 and 7 prior to Sonar treatments. Treatment dates are included just below the table. Thermocline depths at each site are highlighted.

May 16, 2007				
Depth (m)	Temp (C)		DO (mg/L)	
	Site 7	Site 2	Site 7	Site 2
Sub-surface	19.6	18.9	8.45	8.66
1	19.6	18.9	8.33	8.56
2	19.5	19.0	8.21	8.63
3	19.5	19.0	8.17	8.25
4	19.4	18.3	8.22	7.29
5	19.4	15.9	8.32	5.77
6	16.3	15.1	5.71	4.91
7	13.5	13.3	4.51	3.07
8	12.1	10.7	4.09	0.73
9	10.6	9.6	3.25	0.20
10	9.5	9.3	2.33	0.12
11	8.9	9.0 (bottom)	0.36	0.09
12	8.6	n/a	0.20	n/a
13	8.6 (bottom)	n/a	0.13	n/a

June 26, 2007				
Depth (m)	Temp (C)		DO (mg/L)	
	Site 7	Site 2	Site 7	Site 2
Sub-surface	26.2	26.1	8.06	7.67
1	26.1	26.1	8.11	7.70
2	24.7	25.1	5.49	6.71
3	24.2	23.6	5.03	5.68
4	23.7	23.0	4.07	4.05
5	23.3	21.8	2.85	2.19
6	22.6	18.7	1.35	0.13
7	18.9	16.6	0.11	0.09
8	16.7	13.8	0.07	0.06
9	14.0	12.1	0.05	0.04
10	11.9	10.6	0.03	0.03
11	10.2	n/c (bottom)	0.02	n/c
12	9.4	n/a	0.02	n/a
13	n/c (bottom)	n/a	n/c	n/a

n/a = not applicable; n/c = not collected
2007 Sonar treatment dates: May 18 (initial Sonar) and June 27 (bump Sonar).

Figure 24. Lake posting for herbicide application for hydrilla control.

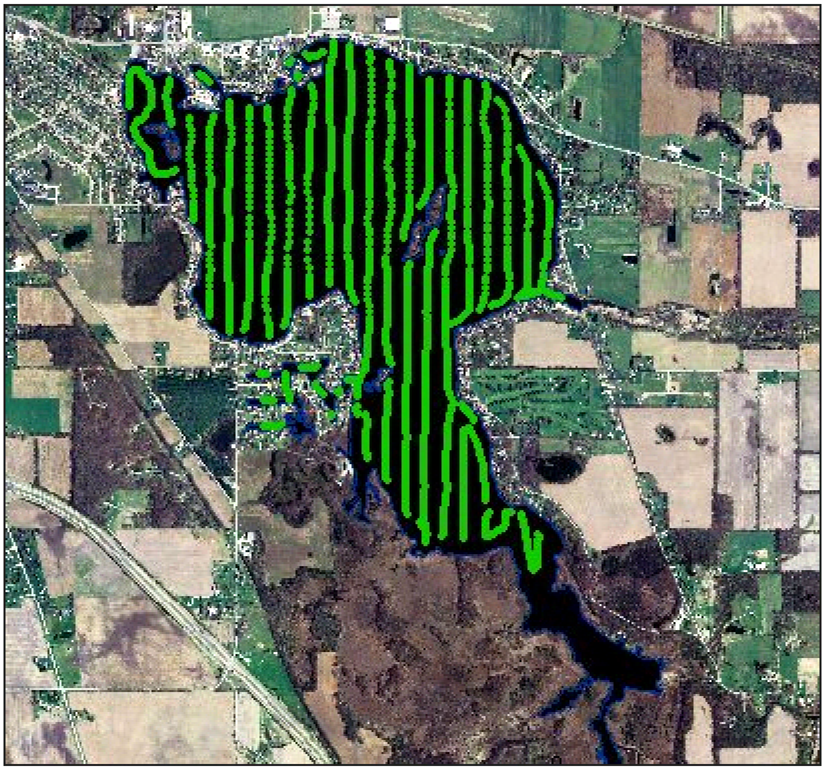


Figure 25. Initial Sonar AS application track, May 18, 2007.

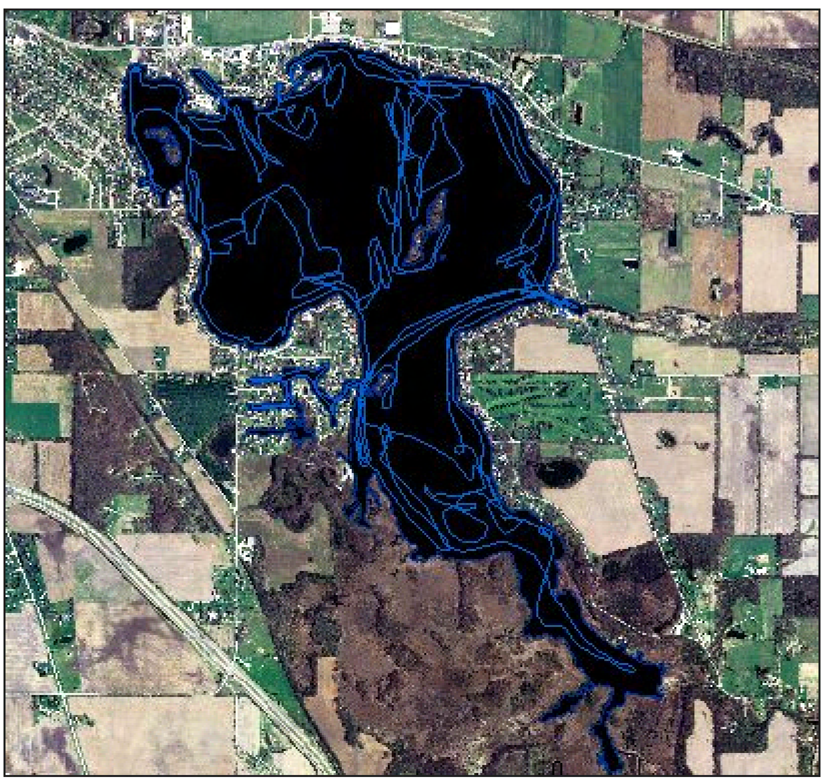


Figure 26. Initial Sonar Q application track, May 18, 2007.

A bump treatment was completed on June 27, 2007 (41 days after initial treatment) with a combination of Sonar AS and Q to bring the Sonar residue back to a minimum of 6 ppb. A total of 1.84 ppb Sonar A.S. and 10 ppb Sonar Q were applied based on a maximum depth of 17-feet (5.2-meters) (thermocline depth from June 26, 2007 data) (Table 21). Figures 27 & 28 illustrate the application routes for the bump treatment.

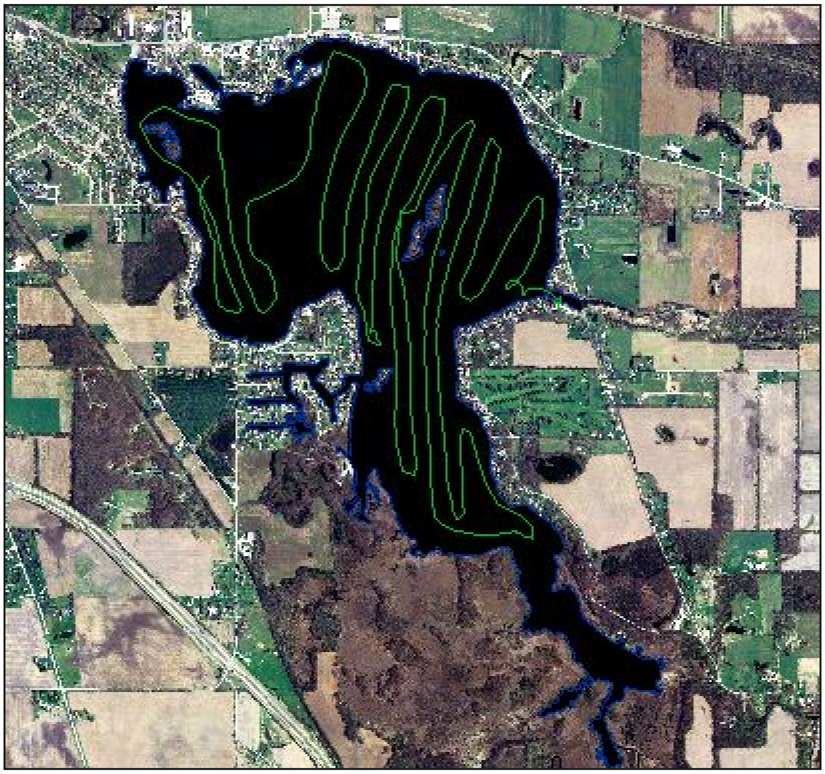


Figure 27. Sonar AS "bump" application track, June 27, 2007.

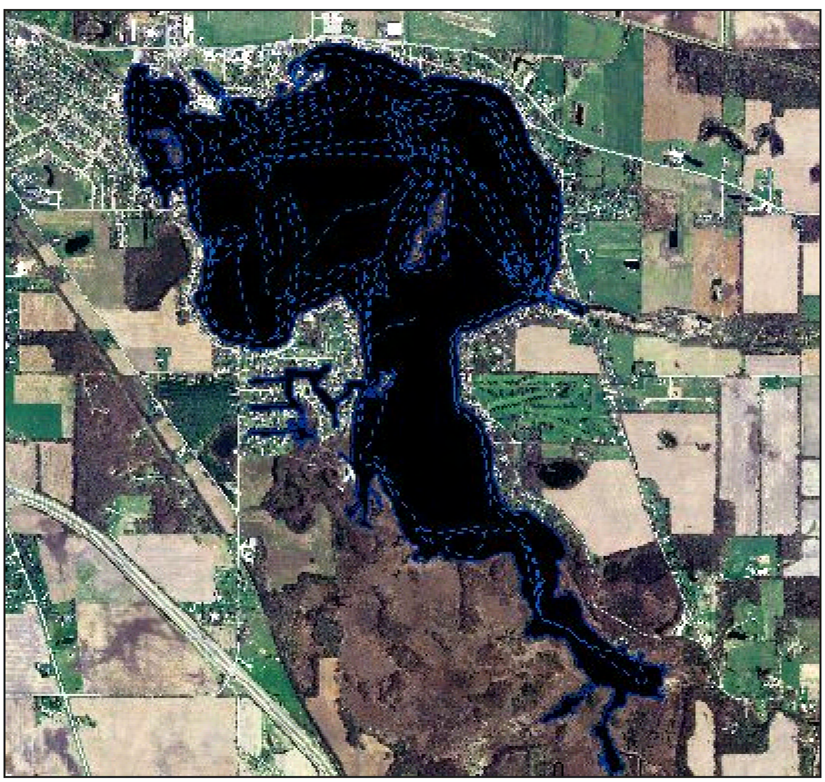


Figure 28. Sonar Q "bump" application track, June 27, 2007.

4.2 Herbicide Residue Monitoring

The FasTEST was used to monitor Sonar concentration 4, 15, 29, 40, 56, 70, 84, 98, 124, 153, and 180 days following initial treatment (15, 29, 43, 57, 83, 112, and 139 days after the bump). The FasTEST ensured the target concentrations were achieved and maintained for the 180-day period. FasTESTs were collected from eight permanent stations located throughout Lake Manitou (Figure 29). Eleven sets of FasTESTs were collected and results are summarized below in Tables 22 and 23, Chart 4, and Figure 30. FasTEST results indicate the target concentration of 6 ppb was achieved 4 days after application. Sonar concentrations were reduced to a lake-wide average of 4.4 ppb 29 days after application, which resulted in a bump treatment being scheduled for June 27. The day before the bump treatment, residues had dropped to 3.3 ppb. There was limited risk that hydrilla would recover at this concentration and treatments were expected to continue to have a desired effect on hydrilla based on PlanTEST results (Chart 3). The bump treatment established residues greater than the target dose of 6 ppb into August. Based on the response of hydrilla to the treatments, when residues dropped below the 6 ppb target on August 9th it was determined residues would continue to monitored. A bump treatment would be conducted if necessary based on reconnaissance surveys. No additional treatment was necessary.

At 15 days after the bump treatment (DABT), concentrations of Sonar were 1.0 ppb or less below the thermocline. As the thermocline depth became shallower (57 DABT), some Sonar was probably trapped below the thermocline as 1.9 to 4.7 ppb was detected. The thermocline depth changed from 6-7 m 15 DABT to 2-4 m 57 DABT. By 112 DABT, the thermocline depth was 9 to 10 meters, creating near isothermal conditions that resulted in more uniform mixing (Table 23).

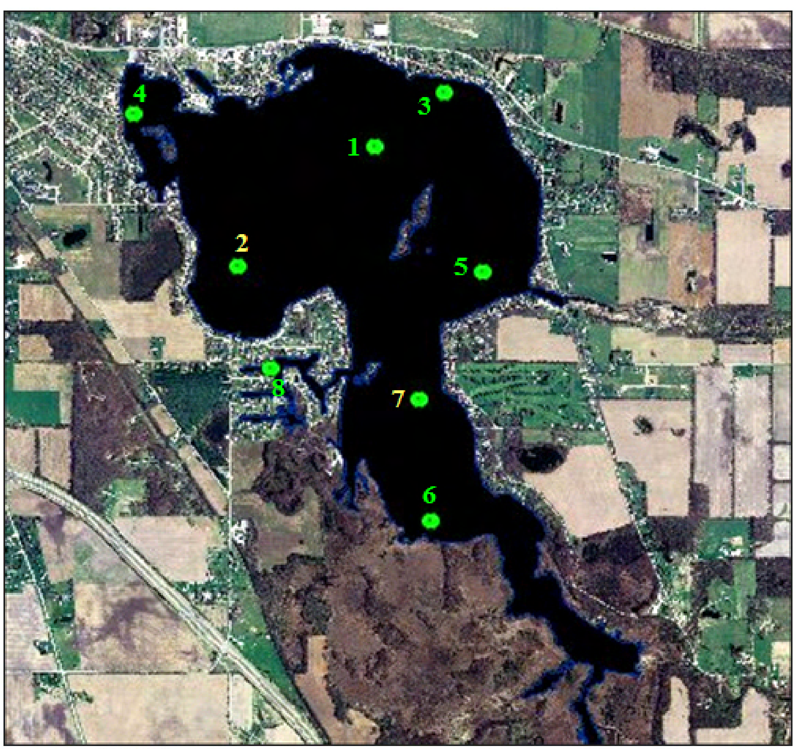


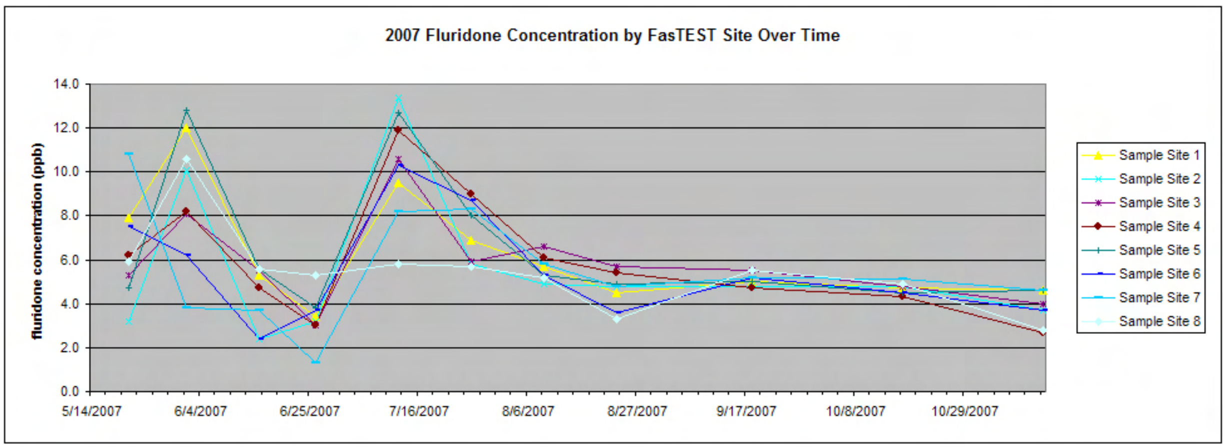
Figure 29. Permanent FasTEST sample locations during 2007.
Green points are the FasTEST monitoring sites with corresponding site numbers. Yellow site *numbers* are the two deep-water sampling sites.
(See Table 3 for site coordinates.)

Table 22. Concentrations of 2007 FasTEST results from surface water samples.

Treatment Dates:	Initial AS+Q 5/17/2007	Bump AS+Q 6/27/2007
Target Concentration:		
AS	6.4	1.8
+ Q	4.0	10.0
Total	10.4	11.8

	FasTEST Sample Collection Dates										
	5/21/2007	6/1/2007	6/15/2007	6/26/2007	7/12/2007	7/26/2007	8/9/2007	8/23/2007	9/18/2007	10/17/2007	11/13/2007
DAT -->	4	15	29	40	15	29	43	57	83	112	139
	Sonar Concentration (ppb)										
Sites 1	7.9	12.0	5.3	3.4	9.5	6.9	5.7	4.5	5.0	4.7	4.6
2	3.2	10.1	2.4	3.2	13.4	5.8	4.9	4.8	4.8	4.8	3.7
3	5.3	8.1	5.5	3.0	10.6	5.9	6.6	5.7	5.5	4.8	4.0
4	6.2	8.2	4.7	3.0	11.9	9.0	6.1	5.4	4.7	4.3	2.7
5	4.7	12.8	5.6	3.8	12.7	8.0	5.3	4.9	5.0	4.5	4.6
6	7.5	6.2	2.4	3.7	10.3	8.7	5.3	3.6	5.2	4.5	3.7
7	10.8	3.8	3.7	1.3	8.2	8.3	5.8	4.8	5.2	5.1	4.6
8	5.9	10.6	5.6	5.3	5.8	5.7	5.2	3.3	5.5	4.9	2.8
Lake Avg	6.4	9.0	4.4	3.3	10.3	7.3	5.6	4.6	5.1	4.7	3.8

2007 treatment dates: May 18 (initial Sonar); June 6 (2-acre contact); June 27 (bump Sonar)



2007 treatment dates: May 18 (initial Sonar); June 6 (2-acre contact); June 27 (bump Sonar)

Chart 4. Sonar concentration by FasTEST site during 2007.

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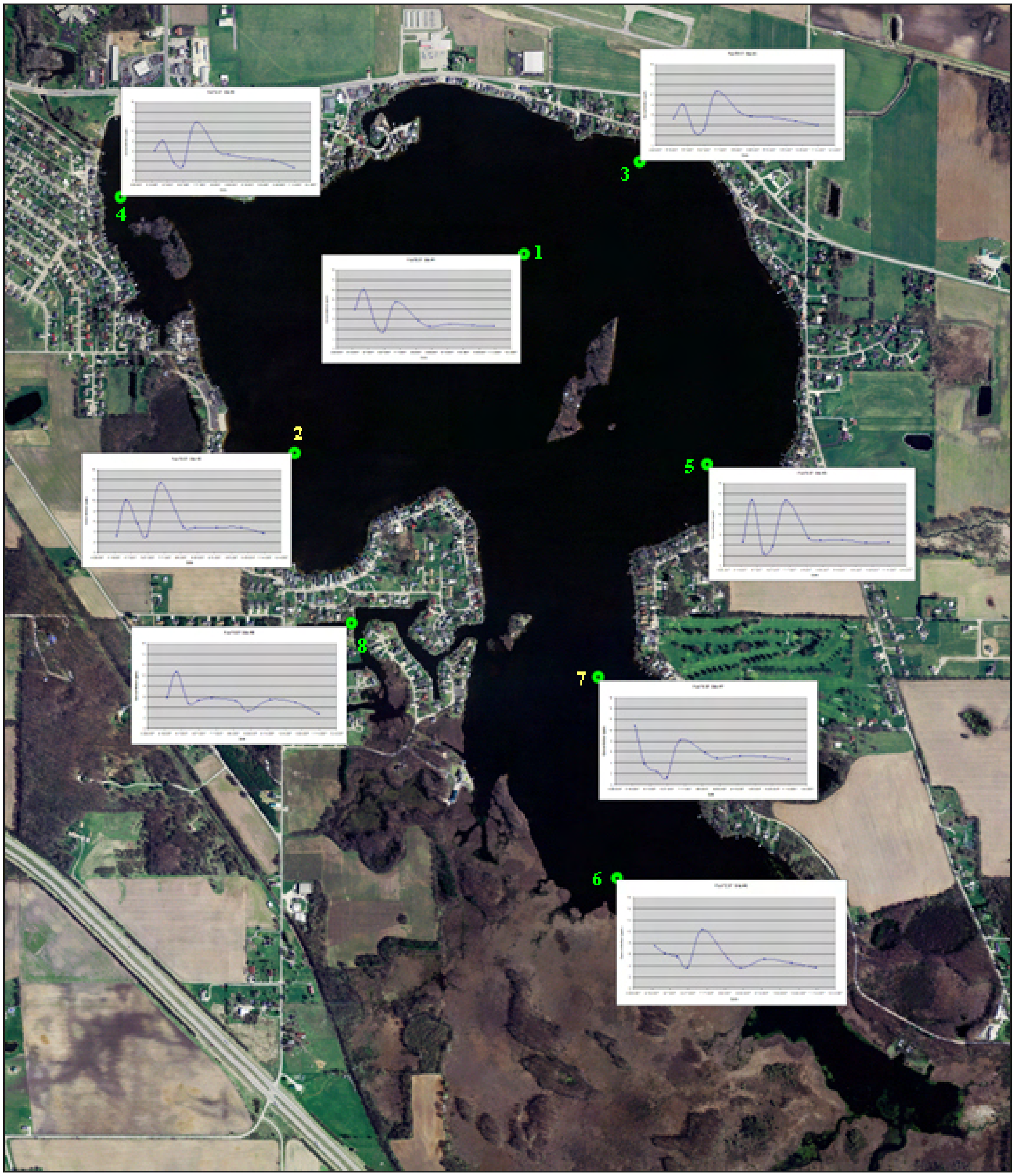

Figure 30. Map-graph of FasTEST results per sample location.
Green points are the FasTEST monitoring sites with corresponding site numbers.
Yellow site *numbers* are the two deep-water sampling sites.

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Table 23. FasTEST, Temperature, and Dissolved Oxygen Depth Profiles at Deep-Water Stations 2 and 7.

		Fastest, Temperature and Dissolved Oxygen Depth Profiles at Deep-Water Sites								
	DABT[1]->	**7/12/2007 15**			**8/23/2007 57**			**10/17/2007 112**		
	Depth (m)	**FasTEST**	Temp	D O_2	**FasTEST**	Temp	D O_2	**FasTEST**	Temp	D O_2
Station 2	0	**13.4**	66.0	8.20	**4.8**	77.0	8.11	**4.8**	62.8	8.22
	1		65.7	8.22		76.9	8.11		62.5	8.20
	2		65.5	8.19		76.8	8.09		62.2	8.15
	3	**9.9**	65.2	8.14	**4.5**	74.2	7.07	**3.7**	62.1	8.44
	4		63.5	7.27		73.5	6.15		62.0	8.29
	5		62.0	6.77		73.3	5.50		62.0	8.30
	6	**2.7**	60.8	5.98	**4.6**	70.2	0.48	**4.4**	61.6	5.73
	7		57.4	3.49		66.0	0.11		61.2	4.59
	8		53.7	2.13		61.2	0.06		61.0	3.58
	9	**1.0**	50.8	0.77	**2.0**	56.9	0.04	**2.9**	60.3	1.10
	10		47.0	0.09		53.7	0.03		54.7	0.15
Station 7	0	**8.2**	69.5	8.65	**4.8**	79.0	8.25	**5.1**	63.4	7.40
	1		69.5	8.34		78.8	8.28		63.2	7.35
	2		68.2	8.34		78.2	8.17		63.0	7.35
	3	**10.3**	66.8	8.37	**4.9**	77.9	7.85	**4.7**	62.9	7.36
	4		66.3	8.21		75.3	5.23		62.7	7.36
	5		65.3	7.62		74.4	4.14		62.6	7.10
	6	**8.6**	62.8	6.30	**4.7**	73.4	2.66	**5.6**	62.5	6.54
	7		60.9	5.39		72.5	1.29		62.4	6.24
	8		56.7	3.67		66.5	0.11		63.3	6.21
	9	**<1**	50.9	2.61	**1.9**	60.9	0.07	**4.5**	61.9	3.52
	10		48.7	1.83		57.7	0.04		61.0	0.18
	11		47.5	0.73		54.6	0.04		58.3	0.13
	12		46.6	0.09		-	-		-	-

[1]DABT = Days after bump treatment.
The double-lined row dividers indicate the presence of a second thermocline.

4.3 Contact Herbicide Treatment

A 2-acre area at the IDNR access site was also treated with contact herbicides in an effort to reduce the threat of any vegetation being carried on watercraft and trailers as they are removed from the lake (Figure 31). This area was treated on June 6, 2007 by IDNR District Fisheries Biologist. This area was treated with 2.5 gallons of Komeen and 2.5 gallons Reward (a.i.: diquat). Plans were in place to treat any hydrilla biomass that occurred prior to or after the initial Sonar application using Komeen, however, no viable hydrilla plants were observed throughout the season and no contact herbicide treatment was completed.

Figure 31. IDNR 2-acre lake-access contact treatment site (yellow polygon), June 6, 2007.

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5.0 ACTION PLAN UPDATE

5.1 Plan Update

Hydrilla produces large numbers of tubers that can remain dormant in the sediment for several years. This fact makes eradication difficult but not impossible. It is necessary to continue treatments for 3-4 consecutive years (or longer) in order to deplete the tuber bank. If treatments were not completed in 2008 tuber densities may return to pre-treatment levels rapidly, likely within a year. The first year of Sonar application resulted in successful control of hydrilla, in a year that experienced unusually low rainfall. The lack of rainfall likely contributed to the prolonged exposure to effective residues. The timing of the treatment coincided with hydrilla tuber sprouting, which is expected to be similar in 2008. The treatments resulted in impact to the native submersed plant community, which was expected due to the importance placed on successful hydrilla control and the overall low species richness.

In 2008, modifications may be necessary to the Sonar formulations used, concentrations applied, and to the number of applications conducted if more selectivity is desired. A lower concentration of Sonar could be effective on hydrilla while maximizing selectivity, and relatively high concentrations of Sonar should be avoided in July and August. If the DNR desires to proceed with the program achieving greater levels of selectivity, then lower effective concentrations should be applied with more frequent application with more reliance on Sonar A.S. The Sonar concentration should be maintained at a minimum between 3 and 6 ppb throughout the growing season. The whole lake (above the thermocline) should be treated with Sonar A.S. at a rate of 6 ppb and maintained above 3 ppb with subsequent bump treatments (probably 3 and possibly 4 total treatments). This lake-wide treatment would control any hydrilla not accounted for in surveys or previously detected. In addition, Sonar Q will not be applied to the entire littoral zone. Instead, Sonar PR will be applied to 18 areas where hydrilla was previously identified (and one area at the inflow). These areas range in size from 4.1 to 17.7 acres in size and total 161 acres (average depth approximately 4 feet). The concentration applied to theses areas will range from 40 to 100 ppb in the treated area. In-water concentrations will only be a fraction of that applied due to the sustained release of the pellets and rapid dilution from these areas. The total Sonar PR applied will be split into 3 treatments: 50% on day 1, and 25% each on day 45 and 90. The first treatment would result in a theoretical lake wide average of 3.1 ppb if 100% of the herbicide was released immediately (and a 17 foot thermocline). This protocol would allow for higher concentrations applied to areas with known hydrilla while minimizing concentrations on the whole lake and minimizing pellet application to the entire littoral zone. If selectivity in 2007 was acceptable, then some modification to the program may still be justified to improve on results obtained in 2007 expecting greater dilution under normal rainfall patterns.

Two tuber sampling events should take place in 2008. Sampling methods should be similar to 2007. The spring 2008 tuber sampling should be similar to the May 2007 sampling effort. This sampling should focus on identifying additional areas that contain hydrilla tubers that have not previously been sampled. Samples will not be conducted at the permanent tuber sampling stations spring 2008. If new areas with high density of tubers are found in the spring, additional permanent tuber monitoring stations should be established. The fall 2008 tuber sample should return to all permanent monitoring stations to monitor tuber attrition at those sties. Future tuber sampling effort may have to be adjusted as the tuber bank becomes depleted, as previously mentioned. Tuber sampling can increase to a point as tuber densities decrease, but “zero” tubers at the sampling sites should not be extrapolated to the whole lake or sampling area once zero is achieved. For example, no tubers were found at Station 1 during the September 2007 survey (minus the expanded area). However, this station should not be aborted and surveys for tubers should continue and it should be expected to find tubers at this site in 2008.

It is also important to continue monitoring the submersed vegetation community with two Tier II surveys in 2008 (one late spring and one late summer). This will allow plant managers the ability to quantify changes in the native plant community. Similar surveys should be continued after the Sonar treatments are complete in order to detect any reintroductions of invasive species and monitor native vegetation recovery.

Finally, both Eurasian watermilfoil and curlyleaf pondweed (low abundance) were also present in Lake Manitou prior to the eradication effort on hydrilla. Both these species are susceptible to the Sonar concentrations being applied to control hydrilla, and were controlled by the 2007 Sonar treatments. Therefore, unless the seed bank of Eurasian watermilfoil and turion/seed bank of curlyleaf pondweed are long-lived (>3 years), then eradication of these 2 invasive species may also be attainable in Lake Manitou with repeated Sonar treatments.

The original AMVP established three management goals:

1) Develop or maintain a stable diverse aquatic plant community that supports a good balance of predator and prey fish and wildlife species, good water quality, and is resistant to minor habitat disturbances and invasive species.
2) Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species.
3) Provide reasonable public access while minimizing the negative impacts on plant and wildlife species.

Even after the introduction of hydrilla to Lake Manitou, the overall aquatic plant management objectives remain relatively the same: establish a diverse aquatic plant community, control aquatic invasive species, and provide reasonable public access. Currently, controlling hydrilla and eradicating this invasive species is paramount to the other objectives outlined in this plan. It is not unreasonable and should remain a goal to implement the other objectives long-term. Some of these objectives are realistic while hydrilla control is ongoing, and minor changes to the hydrilla control program are being implemented to balance eradication efforts vs. other lake management objectives. Although the native species richness in Lake Manitou has historically been low, these species should recover to some extent during and/or following eradication efforts. Some minor introduction of additional native species may be justified long-term, as the plant community was historically dominated by a single species (i.e. eelgrass).

5.2 Budget Update

Budget review and updated cost projections are based on contract parameters.

The 2007 project cost was substantially below budget as a result of planned adaptive management. Less Sonar was needed for a number of reasons including lower than expected flow, precise FasTEST residue monitoring, and project management.

Table 24. Budget update for 2007 and 2-year projections

Year	Budget anticipated	Actual expenditures
2007	$500,000 (plus contingency $150,000)	$331,991
2008	$450,000	--
2009	$466,765	--

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6.0 PUBLIC INVOLVEMENT

Public involvement is an important aspect of any vegetation management plan, but it takes on a whole new level of importance when dealing with an invasive species like hydrilla. A public meeting sponsored by the Indiana Lakes Management Society, was held at the Lake Manitou Elks Club on February 24th 2007 to inform the public regarding the discovery of hydrilla in Lake Manitou, information on the plant and the plans to attempt eradication of the plant from the lake. A group of speakers were assembled by ILMS personnel for the meeting including: Dr. Dick Osgood, Lake Management Consultant, Minnesota; Dr. Michael Smart, U.S. Army Corp of Engineers Vicksburg, MS; Doug Keller, IDNR Aquatic Species Coordinator; Orv Huffman, Lake Manager for Lake Manitou; and Bob Johnson, SePRO Corporation. The meeting was well attended with approximately 120 in attendance. Attendees included Lake Manitou and Rochester residents, other regional Lake Association members, IDNR Enforcement personnel, and others. Consensus of those present was favorable for the IDNR plan to attempt eradication of hydrilla from Lake Manitou.

IDNR Aquatic Invasive Species Coordinator, Doug Keller has headed up the public involvement aspect of the vegetation management plan. Actions which Mr. Keller has undertaken in order to educate and inform the public concerning hydrilla are summarized below:

- Attended Lake Manitou Association (LMA) meeting in the fall of 2006 to let the public know about the hydrilla discovery and access closure
- Attended a meeting in February, 2007 organized by ILMS and LMA to advise the public on the likely chemical control strategy
- Participated in a radio interview on a Rochester station on May 18
- Attended an LMA meeting in July 2007 to update Association on progress of treatment
- Wrote an article for Lake line concerning the hydrilla eradication project in June 2007
- Wrote articles for the Midwest Aquatic Plant Management Society (MAPMS) in 2006 and 2007
- Issued two news releases in the fall of 2006
- Issued two news releases during the 2007 treatment season
- Distributed information to state lake associations to assist in hydrilla identification in order to encourage early detection at other locations
- Purchased Stop Aquatic Hitchhiker signs and installed at nearly all DNR owned public access sites
- Regularly contributed information to the Rochester Sentinel
- Interviewed with the South Bend Tribune concerning Lake Manitou
- Presented hydrilla discovery and control actions in 2007 at a Great Lakes ANS Panel meeting, Mississippi River Basin ANS Panel, MAPMS, three category 5 (aquatic applicator) training sessions, Indiana Lake Management Society annual conference, Great Lake Commission, Ohio Rapid Response planning meeting, Southern Illinois Weed Management District meeting, and state budget committee meeting (e-mail from Doug Keller, Aquatic Invasive Species Coordinator, IDNR).

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Appendix

May 14 to 17 2007 Tuber sampling
Personnel:
SePRO Corporation - Tyler Koschnick, Bob Johnson, Sarah Miller, Sam Barrick
Aquatic Control - Dave Isaacs, Nate Long, Brendan Hastie, Joey Leach, Reid Morehouse, Ben

A total of 562 inch core samples from 126 sites were collected to locate sediments containing hydrilla propagules.
Due to the incipient stage of the hydrilla infestation and lack of detailed coverage maps, hydrilla was difficult to find in high densities. At each site (waypoint), typically 4 individual core samples were collected and sorted using wash racks/buckets with 5/32 inch holes. Cores were 4 inch in diameter and ranged in depth from 2 to 20 inches. Rake tosses (minimum 4) were added at each site to sample a larger area for hydrilla. In addition, individual species were noted as points indicated. Due to the high abundance of eelgrass, eelgrass tubers were added as well.

Five permanent tuber sampling stations were identified based on hydrilla propagules collected and presence of vegetative tissue. At each station, 50 core samples were taken (total 250). The majority of hydrilla propagules were already sprouted, and only a few turions were found (sprouted). Length of hydrilla from tuber to tip of sprout averaged approximately 4 to 5 inches.

Table 1. Summary data for 5 permanent hydrilla propagules monitoring stations, with 50 four-inch cores (0.0874 ft^2) pulled from each station (Total area = 4.4 ft^2 or 0.0001 acre)

Site	Waypoint	Sprouting hydrilla tubers	Non-sprouting hydrilla tubers	Sprouting hydrilla turions	Eelgrass tubers	Sample area (ft^2)
Lighthouse Bay – Station 1	083 T1	8	0	0	101	1750
Dollar Store Bay – Station 2	084 T1	16	21	0	148	1250
White dock – Station 3	085 T1	34	14	1	78	400
Poet’s Point – Station 4	086 T1	40	2	0	1	750
Poet’s Bay – Station 5	087 T1	11	3	0	0	1250
TOTAL	-	109	40	1	328	5400

September 17 2007 Tuber sampling
Personnel:
SePRO Corporation - Tyler Koschnick, Bob Johnson, Sam Barrick
ReMetrix: Jeff Myers
Aquatic Control - Joey Leach, Reid Morehouse

The five permanent tuber sampling stations were sampled with 50 4-inch core samples taken from stations 2 and 3, 53 cores from station 4, and 75 cores taken from stations 1 and 5. An additional 27 cores samples were taken around an expanded area of Station 1 to include the channel connecting the small bay.

Table 1. Summary data for 5 permanent hydrilla propagules monitoring stations, with 50 4-inch (0.0874 ft^2) core samples taken from stations 2 and 3, 53 cores from station 4, and 75 cores taken from stations 1 and 5. (Total area = 26.5ft^2 or 0.00061 acre)

- Site	- Waypoint	Sprouting hydrilla tubers	Non-sprouting hydrilla tubers	Sprouting hydrilla turions	- Eelgrass tubers	Sample area (ft^2)
Lighthouse Bay – Station 1	083 T1	0[a]	0	0	0	2075
Dollar Store Bay – Station 2	084 T1	0	2	0	0	2500
White dock – Station 3	085 T1	2	2	0	0	1250
Poet's Point – Station 4	086 T1	2	8	0	0	1000
Poet's Bay – Station 5	087 T1	1	5	0	0	1750
TOTAL	-	5	17	0	0	8575

a

2 sprouting tubers found in expanded area at the channel – 1 at the entrance and exit to the channel on the N side.

Aquatic Weed Control:
2007 Field Sampling Sheets
(organized by survey date)

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:		Biologist Name:	David Keister
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation		
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage		Aquatic Weed Control
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage		
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage		
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage		
6	Not present	6	Not present	6	No growth	E	End of Life Cycle		

Survey Date:	Date of Treatment:	Gauge Reading:
21-May-07	17-May-07	8.28

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	H_2OTemp	D O_2	Notes
1	Vallisneria americana	3	5	3	M		6.0 feet	65.9 F	-	depth 6.5 feet
2	no plants	6					9.0 feet	66 F	surface 8.20 mg/L	depth 30 feet
								65.7	1m 8.22 mg/L	
								65.5	2m 8.19	
								65.2	3m 8.14	
								63.5	4m 7.27	
								62	5m 6.77	
								60.8	6m 5.98	
								57.4	7m 3.49	
								53.7	8m 2.13	
								50.8	9m 0.77	
								47	10m 0.09	
3	Vallisneria americana	3	5	3	M		bottom visible		-	depth 5 feet
	Potamogeton amplifolius	3	5	3						
4	Vallisneria americana	3	5	3	M		bottom visible		-	depth 5 feet
		3	5	3	M					
	Myriophyllum spicatum	3	5	3	M					
5	nop plants	6					7.0 feet	66.3	-	depth 5 feet
6	Potamogeton crispus	1	5	4			bottom visible	68.3	-	depth 4 feet
	Ceratophyllum demersum	1	4	1						
	Myriophyllum spicatum	1	5	3						
	Vallisneria americana	1	5	3						
7	no plants	6					7.5 feet	69.5	surface 8.65 mg/L	depth 39 feet
								69.5	1m 8.34 mg/L	
								68.2	2m 8.34	
								66.8	3m 8.37	
								66.3	4m 8.21	
								65.3	5m 7.62	
								62.8	6m 6.30	
								60.9	7m 5.39	
								56.7	8m 3.67	
								50.9	9m 2.61	
								48.7	10m 1.83	
								47.5	11m 0.73	
								46.6	12m 0.09	
8	Myriophyllum spicatum		1	5	3		8 feet	69.2	-	depth 10 feet
	Vallisneria americana		3	5	3					
	Ceratophyllum demersum		1	5	1					
	Potamogeton amplifolius		1	5	3					
	Potamogeton pectinatus		1	5	3					
	Potamogeton crispus		1	5	4					
										Summary
										water temp 65-69
										secchi 6-9 feet
										rake sample taken at each shallow fastest point
										rake samples also taken at intermediate sites 10,11, 42, 47, 58 for presence/absence of hydrilla
										no hydrilla found visually or by rake sample

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:		Biologist Name:
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation	David Keister
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage	Company:
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage	Aquatic Weed Control
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage	
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage	
6	Not present	6	Not present	6	No growth	E	End of Life Cycle	

Survey Date: 15-Jun-07

Date of Treatment: 18-May-07

Gauge Reading: 8.15

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	H_2OTemp	D O_2	Notes
1	Vallisneria americana	3	5	3	M		5.8 feet	80.4 F	-	depth 6.5 feet
	Potamogeton pectinatus	1	5	3						
2	no plants	6					4.8 feet	82.9	surface 9.13 mg/L	depth 30 feet
								80.9	1m 9.45 mg/L	
								79.9	2m 9.14	
								76	3m 5.00	
								72.3	4m 3.05	
								68.4	5m 1.39	
								62.6	6m 0.45	
								58.4	7m 0.09	
								55.5	8m 0.06	
								53.6	9m 0.05	
								50.2	10m 0.03	
3	Vallisneria americana	3	5	3	M		bottom visible	78.8	-	depth 5 feet
4	Hydrilla Verticillata	4	5	4	Severe sonar damage		2.9 feet	82.1	-	depth 5 feet
	Vallisneria americana	3	5	3	M					
5	no plants	6					5.0 feet	81.5	-	depth 5 feet
6	Ceratophyllum demersum	2	4	1			3.0 feet	82.2	-	depth 4 feet
	Vallisneria americana	1	5	3						
	Wolfia sp.	1	5	1						
7	no plants	6					3.9 feet	82	surface 11.42 mg/L	depth 39 feet
								81.2	1m 11.52 mg/L	
								80.1	2m 10.94	
								77.1	3m 6.53	
								75.7	4m 4.99	
								73.6	5m 3.41	
								71.1	6m 2.03	
								65.7	7m 0.57	
								60.1	8m 0.14	
								56.1	9m 0.08	
								51.7	10m 0.05	
								49.3	11m 0.04	
								47.9	12m 0.04	
8	Vallisneria americana	3	5	3	M		4.5 feet	81.9	-	depth 10 feet
	Ceratophyllum demersum	2	5	1						
	Myriophyllum Spicatum	4	5	3						
										Summary
										water temp 78.8 -82.9 F
										secchi 3-5.8 feet
										1 hydrilla plant found floating at FasTest site #4, severe sonar damage:
										See photo 20070615_dkAWChydrilla and others
										rake samples taken at each shallow fastest point
										rake samples also taken at intermediate sites 10,11, 42, 43, 57, 58 for presence/absence of hydrilla
										rake sample also taken in Poet's Point Channel
										increasing watermeal observed: See photo 20070615_dkAWCwatermeal
										Most coontail plants showing sonar damage: see photo 20070615_dkAWCcoontaildamage)
										very dry conditions, water level down slightly see photo (07june1awcgauge)

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:	
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage
6	Not present	6	Not present	6	No growth	E	End of Life Cycle

Biologist Name: David Keister

Aquatic Weed Control

Survey Date: 26-Jun-07

Date of Treatment: 17-May-07

Gauge Reading: 8.16 Photo: 20070626_dkAWCgauge

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	Profile Dpth	H_2OTemp	D O_2	Notes
1	Vallisneria americana	3	5	3	M,sonar damage?		4.8 feet		79.2.4 F	-	depth 6.5 feet
	Lemna minor	2	5	3	slight sonar damage						
2	no plants	6					4.7 feet	**Depth**	**Temp (F)**	**DO (mg/L)**	
								surface	78.9	7.67	depth 30 feet
								1m	78.9	7.7	
								2m	77.2	6.71	
								3m	74.5	5.68	
								4m	73.4	4.05	
								5m	71.2	2.19	
								6m	65.7	0.13	
								7m	61.8	0.09	
								8m	56.8	0.06	
								9m	53.7	0.04	
								10m	51.1	0.03	
3	Vallisneria americana	3	5	3	M,sonar damage?		4.9 feet				depth 5 feet
	Lemna minor	2	5	3	slight sonar damage						
	Wolfia sp.	1	5	1							
4	Lemna minor	2	5	3	slight sonar damage		2.6 feet		81.1	-	depth 5 feet
	Vallisneria americana	3	5	3	M						
5	Lemna minor	2	5	3	slight sonar damage		5.5 feet		80.5	-	depth 5 feet
	Wolfia sp.	1	5	1							
6	Ceratophyllum demersum	4	5	1	sonar damage		3.5 feet		78.7	-	depth 4 feet
	Vallisneria americana	3	5	3	M, sonar damage?						
	Wolfia sp.	1	5	1							
7	no plants	6					5.2 feet	**Depth**	**Temp (F)**	**DO (mg/L)**	depth 39 feet
								surface	79.2	8.06	
								1m	79	8.11	
								2m	76.4	5.49	
								3m	75.5	5.03	
								4m	74.7	4.07	
								5m	74	2.85	
								6m	72.6	1.35	
								7m	66.1	0.11	
								8m	62.1	0.07	
								9m	57.2	0.05	
								10m	53.4	0.03	
								11m	50.4	0.02	
								12m	49	0.02	
8	Vallisneria americana	3	5	3	M, sonar damage?		4.7 feet		80.8	-	depth 10 feet
	Ceratophyllum demersum	2	5	1							
	Ceratophyllum demersum	4	5	1	sonar damage						
	Wolfia sp.	1	5	1							
											Summary
											water temp 78.7 - 81.1 F
											secchi 2.6 - 5.5 feet
											rake samples taken at each shallow fastest point
											rake samples also taken at intermediate sites 10,11, 42, 43, 57, 58
											for presence/absence of hydrilla, rake sample also taken in
											Poet's Point Channel, increasing watermeal/duckweeed observed
											some slight sonar damage to duckweed: photo 20070626dkAWCduckweed
											dry conditions, water level up only slightly- see photo (20070626dkAWCgauge)

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:	
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage
6	Not present	6	Not present	6	No growth	E	End of Life Cycle

Biologist Name: David Keister

Aquatic Weed Control

Survey Date: 12-Jul-07

Date of Treatment: 18-May-07

Gauge Reading: 8.06 Photo: 20070712_dkAWC_gauge

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	H_2OTemp		D O_2	Notes
1	Vallisneria ar	3	5	3	M,sonar damage?		4.5 feet	78.7 F		-	depth 6.5 feet
								Depth	Temp (F)	DO (mg/L)	
	no plants	6					5.3 feet	surface	78.8	7.27	depth 30 feet
								1m	78.8	7.31	
								2m	78.7	7.3	
								3m	78.5	7.2	
								4m	78.3	7.2	
								5m	71.3	0.2	
								6m	66.1	0.13	
								7m	61.5	0.09	
								8m	57.5	0.07	
								9m	54	0.06	
								10m	51.8	0.05	
3	Vallisneria ar	3	5	3	M,sonar damage?		5.0 feet	79.5			depth 5 feet
	Ceratophyllu	4	5	1	sonar damage						
	Potamogetor	2	5	3							
4	Chara	1	5	3			4.2 feet	78.7		-	depth 5 feet
5	no plants						4.5 feet	79.8		-	depth 5 feet
6	Lemna mino	2	5	3	slight sonar damage		3.9 feet	79.9		-	depth 4 feet
	Potamogetor	1	5	4							
	Wolfia sp.	1	5	1							
7	no plants	6					4.8 feet	Depth	Temp (F)	DO (mg/L)	depth 39 feet
								surface	79.3	7.57	
								1m	79.4	7.53	
								2m	79.4	7.45	
								3m	79.3	7.34	
								4m	78.7	6.39	
								5m	77.4	4.38	
								6m	77	2.81	
								7m	68.9	0.14	
								8m	64.4	0.09	
								9m	58.2	0.06	
								10m	54.3	0.04	
								11m	51.3	0.03	
8	Lemna mino	2	5	3	slight sonar damage		5.1 feet	80.4		-	depth 10 feet
	Wolfia sp.	1	5	1							
											Summary
											water temp 78.7 - 80.4 F
New											secchi 3.9 - 5.3 feet
											sunny, windy conditions
											rake samples taken at each shallow fastest point
											rake samples also taken at intermediate sites 10,11, 42, 43, 57, 58 for presence/absence of hydrilla
											rake sample also taken in Poet's Point Channel
											eel grass much less abundant than in previous surveys
											less floating vegetation observed than past surveys
											dry conditions, water level dropping see photo (20070712_dkAWC_gauge)
New											no hydrilla found

Lake Manitou Sample Collection

Biologist Name: David Keister

Aquatic Weed Control

Injury:		Cover:		Growth:		Other Indicators:	
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage
6	Not present	6	Not present	6	No growth	E	End of Life Cycle

Survey Date: 26-Jul-07

Date of Treatment: 18-May-07

Gauge Reading: 8.15 (20070726_dkAWC_gauge)

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	H_2OTemp		D O_2	Notes
1	Lemna minor	2	5	3	slight sonar damage		3.9 feet	76.3 F		-	depth 6.5 feet
	Wolfia sp.	1	5	1							
	Algae present										
2	no plants	6					3.6 feet	**Depth**	**Temp (F)**	**DO (mg/L)**	depth 30 feet
								surface	76.8	8.16	
								1m	76.8	8.09	
								2m	76.8	7.97	
								3m	76.7	7.75	
								4m	74.6	4.53	
								5m	72.8	2.34	
								6m	68.9	0.15	
								7m	62.7	0.09	
								8m	57.5	0.06	
								9m	54.1	0.04	
								10m	52.2	0.03	
3	Lemna minor	2	5	3	slight sonar damage		3.9 feet	74.7		-	depth 5 feet
	Wolfia sp.	1	5	1							
	Algae present										
4	Lemna minor	2	5	3	slight sonar damage		3.2 feet	76.3		-	depth 5 feet
	Wolfia sp.	1	5	1							
5	no plants						4.6 feet	77		-	depth 18 feet
6	Lemna minor	2	5	3	slight sonar damage		4.1 feet	76.9		-	depth 4 feet
	Wolfia sp.	1	5	1							
	Algae present										
7	no plants	6					4.3 feet	**Depth**	**Temp (F)**	**DO (mg/L)**	depth 39 feet
								surface	77.4	8.68	
								1m	77.3	8.71	
								2m	77.1	8.45	
								3m	76.6	7.08	
								4m	75.4	7.03	
								5m	74.9	3.26	
								6m	73.8	1.58	
								7m	71	0.12	
								8m	65.7	0.08	
								9m	59.8	0.05	
								10m	54.9	0.03	
								11m	52.9	0.02	
8	Ceratphyllum demersum	3	5				4.2 feet	77.1		-	depth 10 feet

Summary
water temp 74.7 - 77.4 F
secchi 3.2 - 4.6 feet
overcast cloudy
rake samples taken at each shallow fastest point
rake samples also taken at intermediate sites 10,11, 42, 43, 57, 58 for presence/absence of hydrilla
rake sample also taken in Poet's Point Channel
Overall vegetation much less abundant than in previous surveys
less floating vegetation observed than past surveys
Water level up slighty from 8.06 on july 12 to 8.15 see photo (20070726_dkAWC_gauge)
Emergent vegetation showing more sonar damage than on july 12- (see photo 20070726_dkAWC_emergent damage
no hydrilla found
DNR access channel very free of vegetation (see photo 20070726-dkAWC_DNR access channel

Lake Manitou Sample Collection

Injury:
1 Healthy
2 Slight injury
3 Moderate injury
4 Severe Injury
5 Dead plant
6 Not present

Cover:
1 80-100
2 60-79
3 40-59
4 20-39
5 <19
6 Not present

Growth:
1 From Apical Tips or Nodes
2 From Seeds
3 From Root Crown or Rhizomes
4 From Turions or Tubers
5 From Perennial - shrub, tree, etc.
6 No growth

Other Indicators:
T Topped out Vegetation
I Suspected Insect Damage
P Suspected Pathogen Damage
M Mechanical Damage
W Water Fluctuation Damage
E End of Life Cycle

Biologist Name: David Keister
Aquatic Weed Control

Survey Date: 9-Aug-07
Date of Treatment: 18-May-07
Gauge Reading: 8.08 (20070809_dkAWC_gauge)

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	H_2OTemp		D O_2	Notes
1	Lemna minor	2	5	3	slight sonar damage		3.2 feet	84.3		-	depth 6.5 feet
	Wolfia sp.	1	5	1							
	Algae present										
2	no plants	6					3.9 feet	**Depth**	**Temp (F)**	**DO (mg/L)**	depth 30 feet
								surface	84.50	8.22	
								1m	84.40	8.18	
								2m	83.80	7.73	
								3m	82.20	6.63	
								4m	77.90	1.35	
								5m	74.50	0.14	
								6m	69.50	0.10	
								7m	64.50	0.07	
								8m	60.50	0.04	
								9m	54.50	0.02	
								10m	53.70	0.01	
3	Algae present						3.9 feet	84.6		-	depth 5 feet
4	Lemna minor	2	5	3	slight sonar damage		3.1 feet	85.1		-	depth 5 feet
	Wolfia sp.	1	5	1							
	Chara	2	5	3							
	Algae present										
5	no plants						3.5 feet	84.8		-	depth 18 feet
6	Lemna minor	2	5	3	slight sonar damage		3.1 feet	86.6		-	depth 4 feet
	Wolfia sp.	1	5	1							
	Algae present										
7	no plants	6					3.9 feet	**Depth**	**Temp (F)**	**DO (mg/L)**	depth 39 feet
								surface	85.70	8.00	
								1m	85.70	8.01	
								2m	84.70	8.00	
								3m	83.20	6.87	
								4m	80.70	2.99	
								5m	78.50	0.41	
								6m	75.40	0.11	
								7m	71.80	0.08	
								8m	67.10	0.05	
								9m	60.70	0.03	
								10m	55.30	0.01	
								11m	53.10	0.01	
8	Lemna minor	2	5	3	slight sonar damage		3.8 feet	85.5		-	depth 10 feet
	Wolfia sp.	1	5	1							

Summary
water temp 84.3 - 86.6 F
secchi 3.1 - 3.9 feet
partly cloudy, hot
rake samples taken at each shallow fastest point
rake samples also taken at intermediate sites 10,11, 42, 43, 57, 58 for presence/absence of hydrilla
rake sample also taken in Poet's Point Channel
Submersed vegetation very scarce
Duckweed and watermeal still abundant
Water down slighty from 8.15 on july 26 to 8.08 see photo (20070809_dkAWC_gauge)
Emergent vegetation showing more damage than on july 26 - (see photo 20070809_dkAWC_emergent damage
no hydrilla found

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:	
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage
6	Not present	6	Not present	6	No growth	E	End of Life Cycle

Biologist Name: David Keister

Aquatic Weed Control

Survey Date: 23-Aug-07

Date of Treatment: 18-May-07

Gauge Reading: 8.34 (20070823_dkAWC_gauge)

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	H_2OTemp		D O_2	Notes
1	Lemna minor	2	5	3	slight sonar damage		3.6 feet	77		-	depth 6.5 feet
	Wolfia sp.	1	5	1							
2	no plants	6					3.2 feet	**Depth**	**Temp (F)**	**DO (mg/L)**	depth 30 feet
								surface	77.00	8.11	
								1m	76.90	8.11	
								2m	76.80	8.09	
								3m	74.20	7.07	
								4m	73.50	6.15	
								5m	73.30	5.50	
								6m	70.20	0.48	
								7m	66.00	0.11	
								8m	61.20	0.06	
								9m	56.90	0.04	
								10m	53.70	0.03	
3	Algae present						3.1 feet	78			depth 5 feet
4	Lemna minor	2	5	3	slight sonar damage		2.6 feet	77.5		-	depth 5 feet
5	Lemna minor	2	5	3	slight sonar damage		3.9 feet	80		-	depth 5 feet
6	Algae present						3.3 feet	78.5		-	depth 4 feet
7	no plants	6					4.2 feet	**Depth**	**Temp (F)**	**DO (mg/L)**	depth 39 feet
								surface	79.00	8.25	
								1m	78.80	8.28	
								2m	78.20	8.17	
								3m	77.90	7.85	
								4m	5.30	5.23	
								5m	74.40	4.14	
								6m	73.40	2.66	
								7m	72.50	1.29	
								8m	66.50	0.11	
								9m	60.90	0.07	
								10m	57.70	0.04	
								11m	54.60	0.04	
8	no plants						3.9 feet	78.7		-	depth 10 feet

Summary

water temp 77.0 - 80.0 F

secchi 2.6 - 4.2 feet

partly cloudy, breezy

rake samples taken at each shallow fastest point

rake samples also taken at intermediate sites 10,11, 42, 43, 57, 58 for presence/absence of hydrilla

rake sample also taken in Poet's Point Channel

Submersed vegetation very scarce

Duckweed and watermeal seemingly more abundant

Water level up from 8.08 on August 9 to 8.34 see photo (20070823_dkAWC_gauge)

no hydrilla found

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:	
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage
6	Not present	6	Not present	6	No growth	E	End of Life Cycle

Biologist Name: David Keister

Aquatic Weed Control

Survey Date:	Date of Treatment:	Gauge Reading:
18-Sep-07	18-May-07	8.06 (20070918_dkAWC_gauge)

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	H_2OTemp		D O_2	Notes
1	Algae present						4.0 ft	68.7		-	depth 6.5 feet
								Depth	Temp (F)	DO (mg/L)	
2	no plants	6					3.1 ft	surface	70.20	7.76	depth 30 feet
								1m	69.20	7.83	
								2m	68.60	7.86	
								3m	68.20	7.86	
								4m	67.60	7.43	
								5m	67.40	7.23	
								6m	67.00	6.65	
								7m	66.00	3.27	
								8m	66.40	0.14	
								9m	66.50	0.11	
								10m	66.50	0.09	
3	Algae present						3.0 ft	68.2			depth 5 feet
4	Algae present						3.2 ft	68.4		-	depth 5 feet
5	no plants						4.0 ft	70		-	depth 18 feet
6	Algae present						4.3 ft	70.5		-	depth 4 feet
7	no plants	6					3.7 ft	Depth	Temp (F)	DO (mg/L)	depth 39 feet
								surface	71.1	7.88	
								1m	70.20	7.87	
								2m	69.20	7.75	
								3m	68.80	7.58	
								4m	68.30	6.99	
								5m	68.20	7.13	
								6m	67.90	6.75	
								7m	67.60	6.19	
								8m	66.80	3.36	
								9m	64.10	0.20	
								10m	57.70	0.12	
								11m	54.20	0.08	
8	Lemna minor	2	5	3	slight sonar damage		3.4 ft	72.4		-	depth 10 feet
	Wolfia sp.	1	5	1							
											Summary
											water temp 68.2 - 762.4 F
New											secchi 3.0 - 4.3 feet
											sunny,calm, temp in mid 80's
											rake samples taken at each shallow fastest point
											rake samples also taken at intermediate sites 10,11, 42, 43, 57, 58 for presence/absence of hydrilla
											rake sample also taken in Poet's Point Channel
											Submersed vegetation very scarce
											Sago Pondweed bed observed in extreme south end of the lake.
											Water down from 8.34 on August 23 to 8.06 see photo (20070918_dkAWC_gauge)
New											no hydrilla found

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:	
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage
6	Not present	6	Not present	6	No growth	E	End of Life Cycle

Biologist Name: David Keister

Aquatic Weed Control

Survey Date: 17-Oct-07

Date of Treatment: 18-May-07

Gauge Reading: 8.04 (20071017_dkAWC_gauge)

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	H_2OTemp		D O_2	Notes
1	Algae present						4.9	62.4		-	depth 6.5 feet
								Depth	**Temp (F)**	**DO (mg/L)**	
2	no plants	6					5.1	surface	62.80	8.22	depth 30 feet
								1m	62.50	8.20	
								2m	62.20	8.15	
								3m	62.10	8.44	
								4m	62.00	8.29	
								5m	62.00	8.30	
								6m	61.60	5.73	
								7m	61.20	4.59	
								8m	61.00	3.58	
								9m	60.30	1.10	
								10m	54.70	0.15	
3	Algae present						4.0	62.5			depth 5 feet
4	Algae present						4.5	62.7		-	depth 5 feet
5	no plants						5.2	64.5		-	depth 18 feet
6	Algae present						bottom visibl	63.3		-	depth 4 feet
7	no plants	6					6.1	**Depth**	**Temp (F)**	**DO (mg/L)**	depth 39 feet
								surface	63.4	7.40	
								1m	63.20	7.35	
								2m	63.00	7.35	
								3m	62.90	7.36	
								4m	62.70	7.36	
								5m	62.60	7.10	
								6m	62.50	6.54	
								7m	62.40	6.24	
								8m	63.30	6.21	
								9m	61.90	3.52	
								10m	61.00	0.18	
								11m	58.30	0.13	
8	Algae present						5.3	65.1		-	depth 10 feet
											Summary
											water temp 62.4 - 65.1 F
New											secchi 4.0 - 6.1 feet
											sunny, temp 70 F
											rake samples taken at each shallow fastest point
											rake samples also taken at intermediate sites 10,11, 42, 43, 57, 58 for presence/absence of hydrilla
											rake sample also taken in Poet's Point Channel
											Submersed vegetation very scarce
											Water down from 8.06 on 9/18 to 8.04 see photo (20071017_dkAWC_gauge)
New											

Lake Manitou Sample Collection

Injury:		Cover:		Growth:		Other Indicators:	
1	Healthy	1	80-100	1	From Apical Tips or Nodes	T	Topped out Vegetation
2	Slight injury	2	60-79	2	From Seeds	I	Suspected Insect Damage
3	Moderate injury	3	40-59	3	From Root Crown or Rhizomes	P	Suspected Pathogen Damage
4	Severe Injury	4	20-39	4	From Turions or Tubers	M	Mechanical Damage
5	Dead plant	5	<19	5	From Perennial - shrub, tree, etc.	W	Water Fluctuation Damage
6	Not present	6	Not present	6	No growth	E	End of Life Cycle

Biologist Name: David Keister

Aquatic Weed Control

Survey Date: 13-Nov-07

Date of Treatment: 18-May-07

Gauge Reading: 8.22 (2007113_dkAWC_gauge)

Site	Species	Injury	Cover	Growth	Other	Photos	Secchi	H_2OTemp		D O_2	Notes
1	no plants	6					4.2	48.3		-	depth 6.5 feet
2	no plants	6					3.9	**Depth**	**Temp (F)**	**DO (mg/L)**	depth 30 feet
								surface	48.7	11.02	
								1m	48.4	11.09	
								2m	48.0	10.82	
								3m	47.7	10.60	
								4m	47.8	10.52	
								5m	47.7	10.41	
								6m	47.4	10.15	
								7m	47.3	10.17	
								8m	47.2	10.03	
								9m	47.1	9.98	
								10m	47.1	9.86	
3	Algae present						4.1	48.9			depth 5 feet
4	Algae present						3.9	48.3		-	depth 5 feet
	Chara	1	5	3							
5	no plants						4.1	49.6		-	depth 18 feet
6	Algae present						3.8	49.1		-	depth 4 feet
7	no plants	6					4.1	**Depth**	**Temp (F)**	**DO (mg/L)**	depth 39 feet
								surface	49.0	10.87	
								1m	48.5	10.83	
								2m	48.3	10.65	
								3m	48.1	10.31	
								4m	48.0	10.18	
								5m	48.0	10.15	
								6m	47.9	10.15	
								7m	47.9	10.16	
								8m	47.8	10.05	
								9m	47.7	10.00	
								10m	47.4	9.69	
								11m	47.4	9.54	
8	Algae present						4.9	49.7		-	depth 10 feet

Summary

water temp 48.3 - 49.7 F

secchi 3.8 - 4.9 feet

sunny, temp 55 F

rake samples taken at each shallow fastest point

rake samples also taken at intermediate sites 10,11, 42, 43, 57, 58 for presence/absence of hydrilla

rake sample also taken in Poet's Point Channel

Submersed vegetation very scarce - chara, duckweed, watermeal all observed

Water level up from 8.04 on 10/17 to 8.22 see photo (20071113_dkAWC_gauge)

Aquatic Weed Control - 2007 Reconnaisance Surveys
(Field reports from sampling at the eight permanent FasTEST samping sites)

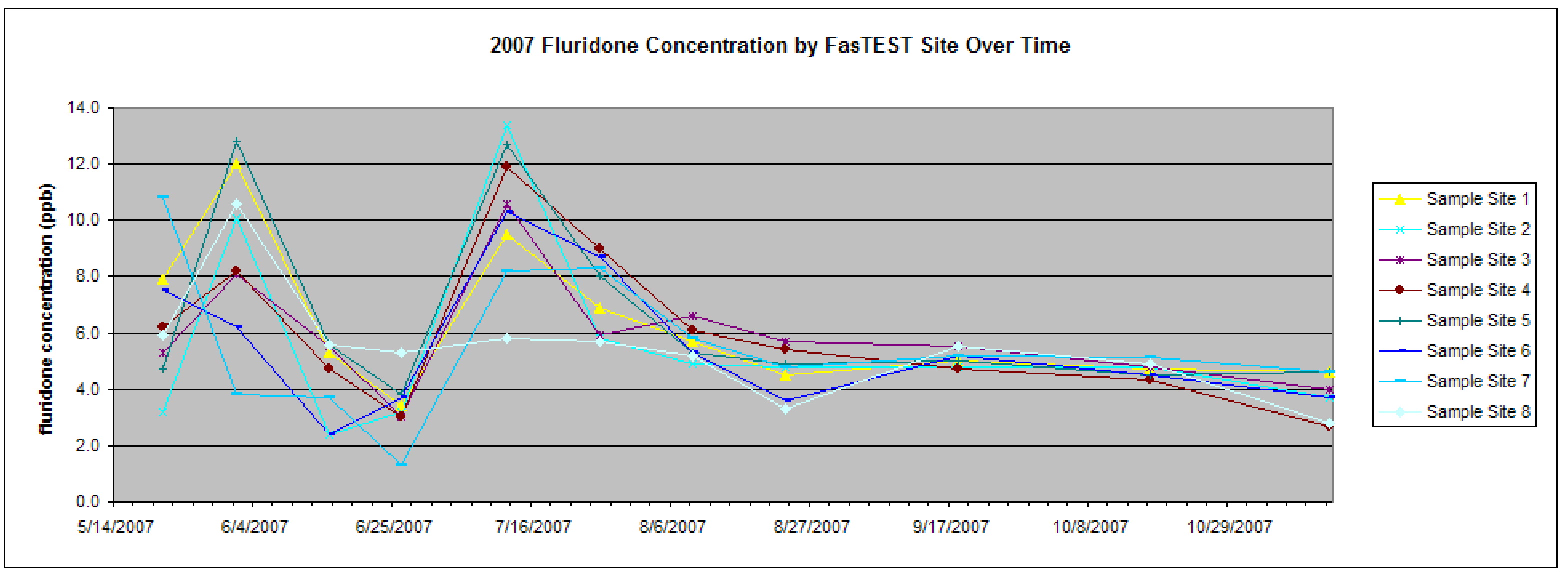
DATE	SITE	SPECIES	COVER	INJURY	GROWTH	OTHER	SECCHI_FT	H2O_DEPTH	H2O_SFC_T	GAUGE	HYDRILLA
5/21/2007	1	Vallisneria americana	<19%	Moderate injury	From Root Crown or Rhizomes	Mechanical Damage	6.0	6.5	65.9	8.28	0
5/21/2007	2	no plant	Not Present	Not Present	No growth		9.0	30.0	66.0	8.28	0
5/21/2007	3	Vallisneria americana	<19%	Moderate injury	From Root Crown or Rhizomes	Mechanical Damage	5.0	5.0		8.28	0
5/21/2007	3	Potamogeton amplifolius	<19%	Moderate injury	From Root Crown or Rhizomes	Mechanical Damage	5.0	5.0		8.28	0
5/21/2007	4	Vallisneria americana	<19%	Moderate injury	From Root Crown or Rhizomes	Mechanical Damage	5.0	5.0		8.28	0
5/21/2007	4	Miriophyllum spicatum	<19%	Moderate injury	From Root Crown or Rhizomes	Mechanical Damage	5.0	5.0		8.28	0
5/21/2007	5	no plant	Not Present	Not Present	No growth		7.0	5.0	66.3	8.28	0
5/21/2007	6	Potamogeton crispus	<19%	Healthy	From Turions or Tubers		4.0	4.0	68.3	8.28	0
5/21/2007	6	Ceratophyllum demersum	20-39%	Healthy	From Apical Tips or Nodes		4.0	4.0	68.3	8.28	0
5/21/2007	6	Myriophyllum spicatum	<19%	Healthy	From Root Crown or Rhizomes		4.0	4.0	68.3	8.28	0
5/21/2007	6	Vallisneria americana	<19%	Healthy	From Root Crown or Rhizomes		4.0	4.0	68.3	8.28	0
5/21/2007	7	no plant	Not Present	Not Present	No growth		7.5	39.0	69.5	8.28	0
5/21/2007	8	Miriophyllum spicatum	<19%	Healthy	From Root Crown or Rhizomes		8.0	10.0	69.2	8.28	0
5/21/2007	8	Vallisneria americana	<19%	Moderate injury	From Root Crown or Rhizomes		8.0	10.0	69.2	8.28	0
5/21/2007	8	Ceratophyllum demersum	<19%	Healthy	From Apical Tips or Nodes		8.0	10.0	69.2	8.28	0
5/21/2007	8	Potamogeton amplifolius	<19%	Healthy	From Root Crown or Rhizomes		8.0	10.0	69.2	8.28	0
5/21/2007	8	Potamogeton pectinatus	<19%	Healthy	From Root Crown or Rhizomes		8.0	10.0	69.2	8.28	0
5/21/2007	8	Potamogeton crispus	<19%	Healthy	From Turions or Tubers		8.0	10.0	69.2	8.28	0
6/15/2007	1	Vallisneria americana	<19%	Moderate injury	From Root Crown or Rhizomes	Mechanical Damage	5.8	6.5	80.4	8.15	0
6/15/2007	1	Potamogeton pectinatus	<19%	Healthy	From Root Crown or Rhizomes		5.8	6.5	80.4	8.15	0
6/15/2007	2	no plant	Not Present	Not Present	No growth		4.8	30.0	82.9	8.15	0
6/15/2007	3	Vallisneria americana	<19%	Moderate injury	From Root Crown or Rhizomes	Mechanical Damage	5.0	5.0	78.8	8.15	0
6/15/2007	4	Hydrilla verticillata	<19%	Severe injury	From Turions or Tubers		2.9	5.0	82.1	8.15	1
6/15/2007	4	Vallisneria americana	<19%	Moderate injury	From Root Crown or Rhizomes	Mechanical Damage	2.9	5.0	82.1	8.15	1
6/15/2007	5	no plant	Not Present	Not Present	No growth		5.0	5.0	81.5	8.15	0
6/15/2007	6	Ceratophyllum demersum	20-39%	Slight Injury	From Apical Tips or Nodes		3.0	4.0	82.2	8.15	0
6/15/2007	6	Vallisneria americana	<19%	Healthy	From Root Crown or Rhizomes		3.0	4.0	82.2	8.15	0
6/15/2007	6	Wolffia spp.	<19%	Healthy	From Apical Tips or Nodes		3.0	4.0	82.2	8.15	0
6/15/2007	7	no plant	Not Present	Not Present	No growth		3.9	39.0	82.0	8.15	0
6/15/2007	8	Vallisneria americana	<19%	Moderate injury	From Root Crown or Rhizomes	Mechanical Damage	4.5	10.0	81.9	8.15	0
6/15/2007	8	Ceratophyllum demersum	<19%	Slight Injury	From Apical Tips or Nodes		4.5	10.0	81.9	8.15	0
6/15/2007	8	Miriophyllum spicatum	<19%	Severe injury	From Root Crown or Rhizomes		4.5	10.0	81.9	8.15	0
6/26/2007	1	Vallisneria americana	<19%	Moderate injury	From Root Crown or Rhizomes	Mechanical Damage	4.8	6.5	79.4	8.16	0
6/26/2007	1	Lemna minor	<19%	Slight Injury	From Root Crown or Rhizomes		4.8	6.5	79.4	8.16	0
6/26/2007	2	no plant	Not Present	Not Present	No growth		4.7	30.0	78.9	8.16	0
6/26/2007	3	Vallisneria americana	<19%	Moderate injury	From Root Crown or Rhizomes	Mechanical Damage	4.9	5.0		8.16	0
6/26/2007	3	Lemna minor	<19%	Slight Injury	From Root Crown or Rhizomes		4.9	5.0		8.16	0
6/26/2007	3	Wolffia spp.	<19%	Healthy	From Apical Tips or Nodes		4.9	5.0		8.16	0
6/26/2007	4	Lemna minor	<19%	Slight Injury	From Root Crown or Rhizomes		2.6	5.0	81.1	8.16	0
6/26/2007	4	Vallisneria americana	<19%	Moderate injury	From Root Crown or Rhizomes	Mechanical Damage	2.6	5.0	81.1	8.16	0
6/26/2007	5	Lemna minor	<19%	Slight Injury	From Root Crown or Rhizomes		5.5	5.0	80.5	8.16	0
6/26/2007	5	Wolffia spp.	<19%	Healthy	From Apical Tips or Nodes		5.5	5.0	80.5	8.16	0
6/26/2007	6	Ceratophyllum demersum	<19%	Severe injury	From Apical Tips or Nodes		3.5	4.0	78.7	8.16	0
6/26/2007	6	Vallisneria americana	<19%	Moderate injury	From Root Crown or Rhizomes	Mechanical Damage	3.5	4.0	78.7	8.16	0
6/26/2007	6	Wolffia spp.	<19%	Healthy	From Apical Tips or Nodes		3.5	4.0	78.7	8.16	0
6/26/2007	7	no plant	Not Present	Not Present	No growth		5.2	39.0	79.2	8.16	0
6/26/2007	8	Vallisneria americana	<19%	Moderate injury	From Root Crown or Rhizomes	Mechanical Damage	4.7	10.0	80.8	8.16	0
6/26/2007	8	Ceratophyllum demersum	<19%	Slight Injury	From Apical Tips or Nodes		4.7	10.0	80.8	8.16	0
6/26/2007	8	Ceratophyllum demersum	<19%	Severe injury	From Apical Tips or Nodes		4.7	10.0	80.8	8.16	0
6/26/2007	8	Wolffia spp.	<19%	Healthy	From Apical Tips or Nodes		4.7	10.0	80.8	8.16	0
7/12/2007	1	Vallisneria americana	<19%	Moderate injury	From Root Crown or Rhizomes	Mechanical Damage	4.5	6.5	78.7	8.06	0
7/12/2007	2	no plant	Not Present	Not Present	No growth		5.3	30.0	78.8	8.06	0
7/12/2007	3	Vallisneria americana	<19%	Moderate injury	From Root Crown or Rhizomes	Mechanical Damage	5.0	5.0	79.5	8.06	0
7/12/2007	3	Ceratophyllum demersum	<19%	Severe injury	From Apical Tips or Nodes		5.0	5.0	79.5	8.06	0
7/12/2007	3	Potamogeton pectinatus	<19%	Slight Injury	From Root Crown or Rhizomes		5.0	5.0	79.5	8.06	0
7/12/2007	4	Chara	<19%	Healthy	From Root Crown or Rhizomes		4.2	5.0	78.7	8.06	0
7/12/2007	5	no plant	Not Present	Not Present	No growth		4.5	5.0	79.8	8.06	0
7/12/2007	6	Lemna minor	<19%	Slight Injury	From Root Crown or Rhizomes		3.9	4.0	79.9	8.06	0
7/12/2007	6	Potemogeton crispus	<19%	Healthy	From Turions or Tubers		3.9	4.0	79.9	8.06	0
7/12/2007	6	Wolffia spp.	<19%	Healthy	From Apical Tips or Nodes		3.9	4.0	79.9	8.06	0
7/12/2007	7	no plant	Not Present	Not Present	No growth		4.8	39.0	79.3	8.06	0
7/12/2007	8	Lemna minor	<19%	Slight Injury	From Root Crown or Rhizomes		5.1	10.0	80.4	8.06	0
7/12/2007	8	Wolffia spp.	<19%	Healthy	From Apical Tips or Nodes		5.1	10.0	80.4	8.06	0
7/26/2007	1	Lemna minor	<19%	Slight Injury	From Root Crown or Rhizomes		3.9	6.5	76.3	8.15	0
7/26/2007	1	Wolffia spp.	<19%	Healthy	From Apical Tips or Nodes		3.9	6.5	76.3	8.15	0
7/26/2007	1	algae present	Present	Present	Present		3.9	6.5	76.3	8.15	0
7/26/2007	2	no plant	Not Present	Not Present	No growth		3.6	30.0	76.8	8.15	0
7/26/2007	3	Lemna minor	<19%	Slight Injury	From Root Crown or Rhizomes		3.9	5.0	74.7	8.15	0
7/26/2007	3	Wolffia spp.	<19%	Healthy	From Apical Tips or Nodes		3.9	5.0	74.7	8.15	0
7/26/2007	3	algae present	Present	Present	Present		3.9	5.0	74.7	8.15	0
7/26/2007	4	Lemna minor	60-79%	Slight Injury	From Root Crown or Rhizomes		3.2	5.0	76.3	8.15	0
7/26/2007	4	Wolffia spp.	80-100%	Healthy	From Apical Tips or Nodes		3.2	5.0	76.3	8.15	0
7/26/2007	5	no plant	Not Present	Not Present	No growth		4.6	5.0	77.0	8.15	0
7/26/2007	6	Lemna minor	<19%	Slight Injury	From Root Crown or Rhizomes		4.1	4.0	76.9	8.15	0
7/26/2007	6	Wolffia spp.	<19%	Healthy	From Apical Tips or Nodes		4.1	4.0	76.9	8.15	0
7/26/2007	6	algae present	Present	Present	Present		4.1	4.0	76.9	8.15	0
7/26/2007	7	no plant	Not Present	Not Present	No growth		4.3	39.0	77.4	8.15	0
7/26/2007	8	Ceratophyllum demersum	<19%	Moderate injury	From Apical Tips or Nodes		4.2	10.0	77.1	8.15	0
8/9/2007	1	Lemna minor	<19%	Slight Injury	From Root Crown or Rhizomes		3.2	6.5	84.3	8.08	0
8/9/2007	1	Wolffia spp.	<19%	Healthy	From Apical Tips or Nodes		3.2	6.5	84.3	8.08	0
8/9/2007	1	algae present	Present	Present	Present		3.2	6.5	84.3	8.08	0
8/9/2007	2	no plant	Not Present	Not Present	No growth		3.9	30.0	84.5	8.08	0
8/9/2007	3	algae present	Present	Present	Present		3.9	5.0	84.6	8.08	0
8/9/2007	4	Lemna minor	<19%	Slight Injury	From Root Crown or Rhizomes		3.1	5.0	85.1	8.08	0
8/9/2007	4	Wolffia spp.	<19%	Healthy	From Apical Tips or Nodes		3.1	5.0	85.1	8.08	0
8/9/2007	4	Chara	<19%	Slight Injury	From Root Crown or Rhizomes		3.1	5.0	85.1	8.08	0
8/9/2007	4	algae present	Present	Present	Present		3.1	5.0	85.1	8.08	0
8/9/2007	5	no plant	Not Present	Not Present	No growth		3.5	5.0	84.8	8.08	0
8/9/2007	6	Lemna minor	<19%	Slight Injury	From Root Crown or Rhizomes		3.1	4.0	86.6	8.08	0
8/9/2007	6	Wolffia spp.	<19%	Healthy	From Apical Tips or Nodes		3.1	4.0	86.6	8.08	0
8/9/2007	6	algae present	Present	Present	Present		3.1	4.0	86.6	8.08	0
8/9/2007	7	no plant	Not Present	Not Present	No growth		3.9	39.0	85.7	8.08	0
8/9/2007	8	Lemna minor	<19%	Slight Injury	From Root Crown or Rhizomes		3.8	10.0	85.5	8.08	0
8/9/2007	8	Wolffia spp.	<19%	Healthy	From Apical Tips or Nodes		3.8	10.0	85.5	8.08	0
8/23/2007	1	Lemna minor	<19%	Slight Injury	From Root Crown or Rhizomes		3.6	6.5	77.0	8.34	0
8/23/2007	1	Wolffia spp.	<19%	Healthy	From Apical Tips or Nodes		3.6	6.5	77.0	8.34	0
8/23/2007	2	no plant	Not Present	Not Present	No growth		3.2	30.0	77.0	8.34	0
8/23/2007	3	algae present	Present	Present	Present		3.1	5.0	78.0	8.34	0
8/23/2007	4	Lemna minor	<19%	Slight Injury	From Root Crown or Rhizomes		2.6	5.0	77.5	8.34	0
8/23/2007	5	Lemna minor	<19%	Slight Injury	From Root Crown or Rhizomes		3.9	5.0	80.0	8.34	0
8/23/2007	6	algae present	Present	Present	Present		3.3	4.0	78.5	8.34	0
8/23/2007	7	no plant	Not Present	Not Present	No growth		4.5	39.0	79.0	8.34	0
8/23/2007	8	no plant	Not Present	Not Present	No growth		3.9	10.0	78.7	8.34	0

Lake Manitou FasTEST Results for 2007

Lake Manitou FasTEST results for 2007

	Initial AS+Q	Bump AS+Q
Treatment Dates:	5/17/2007	6/27/2007
Target Concentration:		
AS	6.4	1.8
+ Q	4.0	10.0
Total	10.4	11.8

		FasTEST Sample Collection Dates										
		5/21/2007	6/1/2007	6/15/2007	6/26/2007	7/12/2007	7/26/2007	8/9/2007	8/23/2007	9/18/2007	10/17/2007	11/13/2007
	DAT -->	4	15	29	40	15	29	43	57	83	112	139
		Sonar Concentration (ppb)										
Sites	1	7.9	12.0	5.3	3.4	9.5	6.9	5.7	4.5	5.0	4.7	4.6
	2	3.2	10.1	2.4	3.2	13.4	5.8	4.9	4.8	4.8	4.8	3.7
	3	5.3	8.1	5.5	3.0	10.6	5.9	6.6	5.7	5.5	4.8	4.0
	4	6.2	8.2	4.7	3.0	11.9	9.0	6.1	5.4	4.7	4.3	2.7
	5	4.7	12.8	5.6	3.8	12.7	8.0	5.3	4.9	5.0	4.5	4.6
	6	7.5	6.2	2.4	3.7	10.3	8.7	5.3	3.6	5.2	4.5	3.7
	7	10.8	3.8	3.7	1.3	8.2	8.3	5.8	4.8	5.2	5.1	4.6
	8	5.9	10.6	5.6	5.3	5.8	5.7	5.2	3.3	5.5	4.9	2.8
Lake Avg		6.4	9.0	4.4	3.3	10.3	7.3	5.6	4.6	5.1	4.7	3.8



LARE Survey, May 31, 2007
Field Data Sheets

Site ID	SITE_NAME	DENSITY	INJURY	PLANT	Latitude	Longitude
1	MA_1	1	2	Coontail	41.06103	-86.17865
1	MA_1	1	2	Eurasian watermilfoil	41.06103	-86.17865
1	MA_1	1	4	Hydrilla	41.06103	-86.17865
2	MA_2	3	1	Vallisneria	41.06144	-86.18037
3	MA_3	1	2	Vallisneria	41.05929	-86.18812
4	MA_4	1	2	Vallisneria	41.05926	-86.18875
5	MA_5	1	2	Vallisneria	41.05534	-86.17974
6	MA_6	1	1	flatstem pondweed	41.05703	-86.18792
6	MA_6	1	1	muskgrass	41.05703	-86.18792
6	MA_6	1	2	Vallisneria	41.05703	-86.18792
7	MA_7	1	1	Coontail	41.05410	-86.17720
7	MA_7	1	2	Vallisneria	41.05410	-86.17720
8	MA_8	5	2	Coontail	41.04462	-86.18513
8	MA_8	3	2	Nuphar	41.04462	-86.18513
9	MA_9	1	1	Alligatorweed	41.06034	-86.19511
9	MA_9	8	1	Duckweed	41.06034	-86.19511
9	MA_9	8	1	Watermeal	41.06034	-86.19511
10	MA_10	8	1	Alligatorweed	41.06098	-86.19650
10	MA_10	1	1	Eurasian watermilfoil	41.06098	-86.19650
10	MA_10	1	1	Large-leaf pondweed	41.06098	-86.19650
10	MA_10	1	1	waterthread pondweed	41.06098	-86.19650
11	MA_11	1	1	Duckweed	41.03450	-86.16610
11	MA_11	1	1	Nuphar	41.03450	-86.16610
11	MA_11	1	1	sago pondweed	41.03450	-86.16610
11	MA_11	8	1	Watermeal	41.03450	-86.16610
12	MA_12	1	2	Coontail	41.03910	-86.17677
13	MA_13	1	2	Coontail	41.03911	-86.17499
13	MA_13	3	1	sago pondweed	41.03911	-86.17499
14	MA_14	3	1	sago pondweed	41.03912	-86.17322
15	MA_15	1	2	Coontail	41.03913	-86.16968
15	MA_15	1	1	curly-leaf pondweed	41.03913	-86.16968
16	MA_16	3	2	Coontail	41.04026	-86.17766
17	MA_17	5	2	Coontail	41.04027	-86.17589
18	MA_18	1	1	Coontail	41.04028	-86.17412
18	MA_18	1	1	curly-leaf pondweed	41.04028	-86.17412
18	MA_18	8	1	sago pondweed	41.04028	-86.17412
19	MA_19	1	2	Coontail	41.04028	-86.17235
20	MA_20	0	--	no plant	41.04029	-86.17057
22	MA_22	1	2	Coontail	41.04142	-86.17856
23	MA_23	1	2	Coontail	41.04144	-86.17324
24	MA_24	1	2	Coontail	41.04258	-86.17945
24	MA_24	1	2	Vallisneria	41.04258	-86.17945
26	MA_26	5	2	Coontail	41.04373	-86.18035
27	MA_27	1	2	Coontail	41.04377	-86.17326
28	MA_28	1	1	Coontail	41.04488	-86.18479
28	MA_28	3	2	Nuphar	41.04488	-86.18479
29	MA_29	1	2	Coontail	41.04490	-86.17947
29	MA_29	1	2	Vallisneria	41.04490	-86.17947
30	MA_30	1	1	Coontail	41.04606	-86.18036
30	MA_30	1	1	Duckweed	41.04606	-86.18036
30	MA_30	1	3	Nuphar	41.04606	-86.18036
30	MA_30	1	1	Watermeal	41.04606	-86.18036
31	MA_31	1	1	sago pondweed	41.04608	-86.17505
31	MA_31	1	2	Vallisneria	41.04608	-86.17505
32	MA_32	1	2	Vallisneria	41.04721	-86.18303
33	MA_33	1	1	sago pondweed	41.04722	-86.17949
33	MA_33	1	4	Vallisneria	41.04722	-86.17949
34	MA_34	1	2	Vallisneria	41.04838	-86.18038
35	MA_35	0	--	no plant	41.04952	-86.18660
36	MA_36	1	1	muskgrass	41.04952	-86.18482
36	MA_36	1	2	Vallisneria	41.04952	-86.18482
37	MA_37	1	1	muskgrass	41.05068	-86.18572
37	MA_37	1	1	sago pondweed	41.05068	-86.18572
37	MA_37	1	4	Vallisneria	41.05068	-86.18572
38	MA_38	1	2	Coontail	41.05069	-86.18395
38	MA_38	1	2	Vallisneria	41.05069	-86.18395
39	MA_39	1	2	Vallisneria	41.05071	-86.18040
40	MA_40	1	2	Coontail	41.05075	-86.17154
41	MA_41	5	2	Coontail	41.05075	-86.16977
41	MA_41	1	2	flatstem pondweed	41.05075	-86.16977
42	MA_42	1	1	sago pondweed	41.05182	-86.19016
42	MA_42	1	2	Vallisneria	41.05182	-86.19016
43	MA_43	1	1	Cattail	41.05185	-86.18484
43	MA_43	1	2	Vallisneria	41.05185	-86.18484
44	MA_44	1	1	muskgrass	41.05186	-86.18307
44	MA_44	1	2	Vallisneria	41.05186	-86.18307
45	MA_45	1	1	sago pondweed	41.05186	-86.18130
45	MA_45	1	2	Vallisneria	41.05186	-86.18130
46	MA_46	1	2	Coontail	41.05187	-86.17952

"--" means ranking not applicable for this species

DENSITY RATINGS
0: No plants retrieved
1: 1-20% of rake teeth filled
3: 20-99% of rake teeth filled
5: 100%+ of rake teeth filled
8: Plant present but unranked

INJURY RATINGS
1: Healthy
2: Slight Injury
3: Moderate Injury
4: Severe Injury
5: Dead Plant

Site ID	SITE_NAME	DENSITY	INJURY	PLANT	Latitude	Longitude
47	MA_47	1	1	sago pondweed	41.05188	-86.17775
47	MA_47	1	2	Vallisneria	41.05188	-86.17775
48	MA_48	1	1	curly-leaf pondweed	41.05189	-86.17598
49	MA_49	1	2	Coontail	41.05190	-86.17243
50	MA_50	1	2	Coontail	41.05191	-86.17066
51	MA_51	1	1	muskgrass	41.05299	-86.18928
51	MA_51	1	2	Vallisneria	41.05299	-86.18928
52	MA_52	1	1	sago pondweed	41.05300	-86.18751
52	MA_52	1	2	Vallisneria	41.05300	-86.18751
53	MA_53	1	2	Eurasian watermilfoil	41.05301	-86.18574
53	MA_53	1	1	sago pondweed	41.05301	-86.18574
53	MA_53	1	2	Vallisneria	41.05301	-86.18574
54	MA_54	1	2	Eurasian watermilfoil	41.05301	-86.18396
54	MA_54	1	1	sago pondweed	41.05301	-86.18396
55	MA_55	1	1	muskgrass	41.05304	-86.17865
55	MA_55	1	2	Vallisneria	41.05304	-86.17865
56	MA_56	1	2	Coontail	41.05305	-86.17687
56	MA_56	1	1	muskgrass	41.05305	-86.17687
56	MA_56	1	2	Vallisneria	41.05305	-86.17687
57	MA_57	1	2	Coontail	41.05308	-86.16978
57	MA_57	1	2	Vallisneria	41.05308	-86.16978
58	MA_58	1	2	Vallisneria	41.05415	-86.19018
59	MA_59	1	2	Coontail	41.05416	-86.18840
59	MA_59	1	1	muskgrass	41.05416	-86.18840
59	MA_59	1	2	Vallisneria	41.05416	-86.18840
60	MA_60	1	2	Eurasian watermilfoil	41.05416	-86.18663
60	MA_60	1	2	sago pondweed	41.05416	-86.18663
60	MA_60	1	2	Vallisneria	41.05416	-86.18663
61	MA_61	1	2	Eurasian watermilfoil	41.05417	-86.18486
61	MA_61	1	1	sago pondweed	41.05417	-86.18486
61	MA_61	1	2	Vallisneria	41.05417	-86.18486
62	MA_62	1	2	Vallisneria	41.05420	-86.17954
63	MA_63	1	2	Coontail	41.05420	-86.17777
63	MA_63	1	1	muskgrass	41.05420	-86.17777
63	MA_63	1	2	Vallisneria	41.05420	-86.17777
64	MA_64	1	1	muskgrass	41.05424	-86.17068
64	MA_64	1	2	Vallisneria	41.05424	-86.17068
65	MA_65	1	1	Vallisneria	41.05531	-86.19107
66	MA_66	1	1	sago pondweed	41.05533	-86.18575
67	MA_67	1	1	muskgrass	41.05534	-86.18398
67	MA_67	1	1	sago pondweed	41.05534	-86.18398
67	MA_67	1	2	Vallisneria	41.05534	-86.18398
68	MA_68	1	3	Vallisneria	41.05536	-86.17866
69	MA_69	1	1	Large-leaf pondweed	41.05537	-86.17689
69	MA_69	1	1	muskgrass	41.05537	-86.17689
69	MA_69	1	1	Vallisneria	41.05537	-86.17689
70	MA_70	0	--	no plant	41.05539	-86.17157
71	MA_71	1	2	Coontail	41.05540	-86.16980
72	MA_72	0	--	no plant	41.05646	-86.19197
73	MA_73	1	1	muskgrass	41.05647	-86.19020
73	MA_73	1	2	Vallisneria	41.05647	-86.19020
74	MA_74	1	1	muskgrass	41.05648	-86.18842
75	MA_75	1	1	muskgrass	41.05649	-86.18665
75	MA_75	1	3	Vallisneria	41.05649	-86.18665
76	MA_76	1	1	muskgrass	41.05653	-86.17779
76	MA_76	1	2	Vallisneria	41.05653	-86.17779
77	MA_77	1	1	sago pondweed	41.05654	-86.17601
77	MA_77	1	2	Vallisneria	41.05654	-86.17601
78	MA_78	1	2	Coontail	41.05656	-86.17070
78	MA_78	1	1	muskgrass	41.05656	-86.17070
78	MA_78	1	2	Vallisneria	41.05656	-86.17070
79	MA_79	1	1	muskgrass	41.05762	-86.19286
80	MA_80	1	2	Vallisneria	41.05763	-86.19109
81	MA_81	1	1	muskgrass	41.05764	-86.18932
82	MA_82	1	1	muskgrass	41.05765	-86.18755
82	MA_82	1	2	Vallisneria	41.05765	-86.18755
83	MA_83	1	1	sago pondweed	41.05765	-86.18577
83	MA_83	1	2	Vallisneria	41.05765	-86.18577
84	MA_84	1	1	sago pondweed	41.05766	-86.18400
84	MA_84	1	2	Vallisneria	41.05766	-86.18400
85	MA_85	0	--	no plant	41.05769	-86.17868
86	MA_86	1	2	Vallisneria	41.05769	-86.17691
87	MA_87	1	2	Coontail	41.05772	-86.17159
87	MA_87	1	1	Vallisneria	41.05772	-86.17159
88	MA_88	1	1	Coontail	41.05879	-86.19199
88	MA_88	1	1	flatstem pondweed	41.05879	-86.19199
88	MA_88	1	2	Vallisneria	41.05879	-86.19199
89	MA_89	1	1	Coontail	41.05880	-86.19021
89	MA_89	1	2	Vallisneria	41.05880	-86.19021

"--" means ranking not applicable for this species

DENSITY RATINGS
0: No plants retrieved
1: 1-20% of rake teeth filled
3: 20-99% of rake teeth filled
5: 100%+ of rake teeth filled
8: Plant present but unranked

INJURY RATINGS
1: Healthy
2: Slight Injury
3: Moderate Injury
4: Severe Injury
5: Dead Plant

LARE Survey, May 31, 2007
Field Data Sheets

Site ID	SITE_NAME	DENSITY	INJURY	PLANT	Latitude	Longitude
90	MA_90	1	2	Coontail	41.05880	-86.18844
90	MA_90	1	2	Hydrilla	41.05880	-86.18844
90	MA_90	1	2	Vallisneria	41.05880	-86.18844
91	MA_91	1	1	muskgrass	41.05881	-86.18667
91	MA_91	1	2	Vallisneria	41.05881	-86.18667
92	MA_92	1	1	sago pondweed	41.05882	-86.18490
92	MA_92	1	2	Vallisneria	41.05882	-86.18490
93	MA_93	1	1	muskgrass	41.05883	-86.18312
93	MA_93	1	1	sago pondweed	41.05883	-86.18312
93	MA_93	1	2	Vallisneria	41.05883	-86.18312
94	MA_94	1	1	muskgrass	41.05884	-86.18135
94	MA_94	1	1	sago pondweed	41.05884	-86.18135
94	MA_94	1	2	Vallisneria	41.05884	-86.18135
95	MA_95	1	1	Vallisneria	41.05884	-86.17958
96	MA_96	1	2	Vallisneria	41.05885	-86.17781
97	MA_97	0	--	no plant	41.05886	-86.17603
98	MA_98	0	--	no plant	41.05887	-86.17426
99	MA_99	1	2	Coontail	41.05888	-86.17249
99	MA_99	1	2	Vallisneria	41.05888	-86.17249
100	MA_100	1	1	muskgrass	41.05994	-86.19465
101	MA_101	1	2	Vallisneria	41.05995	-86.19288
102	MA_102	1	2	Coontail	41.05996	-86.18934
102	MA_102	1	1	Duckweed	41.05996	-86.18934
102	MA_102	1	1	flatstem pondweed	41.05996	-86.18934
102	MA_102	1	2	Vallisneria	41.05996	-86.18934
102	MA_102	1	1	Watermeal	41.05996	-86.18934
103	MA_103	1	1	flatstem pondweed	41.05999	-86.18225
103	MA_103	1	1	sago pondweed	41.05999	-86.18225
103	MA_103	1	2	Vallisneria	41.05999	-86.18225
104	MA_104	1	2	Coontail	41.06000	-86.18047
104	MA_104	1	1	muskgrass	41.06000	-86.18047
105	MA_105	1	1	muskgrass	41.06001	-86.17870
106	MA_106	1	1	muskgrass	41.06002	-86.17693
106	MA_106	1	2	Vallisneria	41.06002	-86.17693
107	MA_107	0	--	no plant	41.06003	-86.17516
108	MA_108	1	2	Coontail	41.06003	-86.17338
108	MA_108	1	1	muskgrass	41.06003	-86.17338
108	MA_108	1	2	Vallisneria	41.06003	-86.17338
109	MA_109	1	2	Coontail	41.06114	-86.18491
109	MA_109	8	1	Duckweed	41.06114	-86.18491
109	MA_109	1	2	Vallisneria	41.06114	-86.18491
109	MA_109	8	1	Watermeal	41.06114	-86.18491
110	MA_110	1	1	Coontail	41.06115	-86.18314
110	MA_110	1	1	muskgrass	41.06115	-86.18314
110	MA_110	1	2	Vallisneria	41.06115	-86.18314
111	MA_111	1	2	Coontail	41.06116	-86.18137
111	MA_111	1	1	muskgrass	41.06116	-86.18137
111	MA_111	1	1	sago pondweed	41.06116	-86.18137
111	MA_111	3	1	Vallisneria	41.06116	-86.18137
112	MA_112	1	2	Large-leaf pondweed	41.06117	-86.17960
112	MA_112	1	2	Vallisneria	41.06117	-86.17960
113	MA_113	1	2	Vallisneria	41.05431	-86.17736
114	DK_1	1	1	muskgrass	41.06074	-86.19453
115	DK_2	0	--	no plant	41.05925	-86.19483
116	DK_3	1	2	Coontail	41.06099	-86.18400
117	DK_4	1	4	Hydrilla	41.06190	-86.18306
117	DK_4	1	2	Vallisneria	41.06190	-86.18306
118	DK_5	1	1	muskgrass	41.05557	-86.19252
118	DK_5	1	1	Vallisneria	41.05557	-86.19252
119	DK_6	1	4	Hydrilla	41.04860	-86.18693
119	DK_6	1	1	muskgrass	41.04860	-86.18693
119	DK_6	1	2	Vallisneria	41.04860	-86.18693
120	DK_7	1	2	Vallisneria	41.04910	-86.18957
121	DK_8	1	2	Coontail	41.04565	-86.18264
121	DK_8	1	1	curly-leaf pondweed	41.04565	-86.18264
121	DK_8	1	1	muskgrass	41.04565	-86.18264
121	DK_8	1	1	sago pondweed	41.04565	-86.18264
122	DK_9	1	2	Coontail	41.04945	-86.17435
122	DK_9	1	2	Vallisneria	41.04945	-86.17435
123	DK_10	1	1	muskgrass	41.05017	-86.17188
123	DK_10	1	2	Vallisneria	41.05017	-86.17188

"--" means ranking not applicable for this species

DENSITY RATINGS
0: No plants retrieved
1: 1-20% of rake teeth filled
3: 20-99% of rake teeth filled
5: 100%+ of rake teeth filled
8: Plant present but unranked

INJURY RATINGS
1: Healthy
2: Slight Injury
3: Moderate Injury
4: Severe Injury
5: Dead Plant

Site ID	SITE_NAME	DENSITY	INJURY	PLANT	Latitude	Longitude
1	MA_1	--	--	Algae	41.06103	-86.17865
1	MA_1	1	1	muskgrass	41.06103	-86.17865
2	MA_2	--	--	Algae	41.06144	-86.18037
2	MA_2	1	1	muskgrass	41.06144	-86.18037
2	MA_2	1	4	Vallisneria	41.06144	-86.18037
3	MA_3	--	--	Algae	41.05929	-86.18812
3	MA_3	1	1	muskgrass	41.05929	-86.18812
4	MA_4	--	--	Algae	41.05926	-86.18875
4	MA_4	1	1	muskgrass	41.05926	-86.18875
5	MA_5	--	--	Algae	41.05534	-86.17974
6	MA_6	--	--	Algae	41.05703	-86.18792
6	MA_6	8		Duckweed	41.05703	-86.18792
6	MA_6	1	1	muskgrass	41.05703	-86.18792
7	MA_7	--	--	Algae	41.05410	-86.17720
7	MA_7	1	1	muskgrass	41.05410	-86.17720
8	MA_8	--	--	Algae	41.04462	-86.18513
8	MA_8	1	1	Coontail	41.04462	-86.18513
8	MA_8	1	1	muskgrass	41.04462	-86.18513
9	MA_9	--	--	Algae	41.06034	-86.19511
9	MA_9	--	--	purple loosestrife	41.06034	-86.19511
9	MA_9	--	--	Water Willow	41.06034	-86.19511
10	MA_10	--	--	Algae	41.06098	-86.19650
10	MA_10	--	--	Water Willow	41.06098	-86.19650
11	MA_11	--	--	Algae	41.03450	-86.16610
11	MA_11	1	1	Coontail	41.03450	-86.16610
11	MA_11	8		Duckweed	41.03450	-86.16610
11	MA_11	--	--	Spirodela species	41.03450	-86.16610
12	MA_12	--	--	Algae	41.03910	-86.17677
13	MA_13	--	--	Algae	41.03911	-86.17499
13	MA_13	1	1	muskgrass	41.03911	-86.17499
14	MA_14	--	--	Algae	41.03912	-86.17322
15	MA_15	--	--	Algae	41.03913	-86.16968
15	MA_15	1	1	Coontail	41.03913	-86.16968
15	MA_15	8		Duckweed	41.03913	-86.16968
15	MA_15	1	1	sago pondweed	41.03913	-86.16968
15	MA_15	--	--	Spirodela species	41.03913	-86.16968
15	MA_15	1	2	Vallisneria	41.03913	-86.16968
16	MA_16	--	--	Algae	41.04026	-86.17766
16	MA_16	8		Duckweed	41.04026	-86.17766
16	MA_16	--	--	Spirodela species	41.04026	-86.17766
17	MA_17	--	--	Algae	41.04027	-86.17589
17	MA_17	8		Duckweed	41.04027	-86.17589
18	MA_18	--	--	Algae	41.04028	-86.17412
19	MA_19	--	--	Algae	41.04028	-86.17235
19	MA_19	8		Duckweed	41.04028	-86.17235
20	MA_20	--	--	Algae	41.04029	-86.17057
20	MA_20	8		Duckweed	41.04029	-86.17057
22	MA_22	--	--	Algae	41.04142	-86.17856
23	MA_23	--	--	Algae	41.04144	-86.17324
24	MA_24	--	--	Algae	41.04258	-86.17945
26	MA_26	--	--	Algae	41.04373	-86.18035
27	MA_27	--	--	Algae	41.04377	-86.17326
28	MA_28	--	--	Algae	41.04488	-86.18479
28	MA_28	1	1	Bladderwort	41.04488	-86.18479
30	MA_30	--	--	Algae	41.04606	-86.18036
31	MA_31	--	--	Algae	41.04608	-86.17505
33	MA_33	--	--	Algae	41.04722	-86.17949
34	MA_34	--	--	Algae	41.04838	-86.18038
35	MA_35	--	--	Algae	41.04952	-86.18660
35	MA_35	1	1	muskgrass	41.04952	-86.18660
36	MA_36	--	--	Algae	41.04952	-86.18482
36	MA_36	1	1	muskgrass	41.04952	-86.18482
36	MA_36	1	4	Vallisneria	41.04952	-86.18482
37	MA_37	--	--	Algae	41.05068	-86.18572
37	MA_37	1	1	muskgrass	41.05068	-86.18572
37	MA_37	8	4	Vallisneria	41.05068	-86.18572
38	MA_38	--	--	Algae	41.05069	-86.18395
38	MA_38	1	1	muskgrass	41.05069	-86.18395
39	MA_39	--	--	Algae	41.05071	-86.18040
41	MA_41	--	--	Algae	41.05075	-86.16977
41	MA_41	1	3	Coontail	41.05075	-86.16977
42	MA_42	--	--	Algae	41.05182	-86.19016
42	MA_42	1	1	muskgrass	41.05182	-86.19016
43	MA_43	--	--	Algae	41.05185	-86.18484
43	MA_43	1	1	muskgrass	41.05185	-86.18484
44	MA_44	--	--	Algae	41.05186	-86.18307
44	MA_44	1	1	muskgrass	41.05186	-86.18307
45	MA_45	--	--	Algae	41.05186	-86.18130
46	MA_46	--	--	Algae	41.05187	-86.17952
46	MA_46	1	3	Coontail	41.05187	-86.17952
47	MA_47	--	--	Algae	41.05188	-86.17775
47	MA_47	1	1	muskgrass	41.05188	-86.17775
48	MA_48	--	--	Algae	41.05189	-86.17598
49	MA_49	--	--	Algae	41.05190	-86.17243
52	MA_52	--	--	Algae	41.05300	-86.18751

"--" means ranking not applicable for this species

DENSITY RATINGS
0: No plants retrieved
1: 1-20% of rake teeth filled
3: 20-99% of rake teeth filled
5: 100%+ of rake teeth filled
8: Plant present but unranked

INJURY RATINGS
1: Healthy
2: Slight Injury
3: Moderate Injury
4: Severe Injury
5: Dead Plant

Site ID	SITE_NAME	DENSITY	INJURY	PLANT	Latitude	Longitude
52	MA_52	1	1	muskgrass	41.05300	-86.18751
53	MA_53	--	--	Algae	41.05301	-86.18574
53	MA_53	8		Duckweed	41.05301	-86.18574
53	MA_53	1	1	muskgrass	41.05301	-86.18574
55	MA_55	--	--	Algae	41.05304	-86.17865
56	MA_56	--	--	Algae	41.05305	-86.17687
56	MA_56	1	2	Coontail	41.05305	-86.17687
56	MA_56	8		Duckweed	41.05305	-86.17687
56	MA_56	--	--	purple loosestrife	41.05305	-86.17687
57	MA_57	--	--	Algae	41.05308	-86.16978
57	MA_57	1	4	Vallisneria	41.05308	-86.16978
59	MA_59	--	--	Algae	41.05416	-86.18840
60	MA_60	--	--	Algae	41.05416	-86.18663
60	MA_60	1	1	muskgrass	41.05416	-86.18663
61	MA_61	--	--	Algae	41.05417	-86.18486
61	MA_61	1	1	muskgrass	41.05417	-86.18486
62	MA_62	--	--	Algae	41.05420	-86.17954
63	MA_63	--	--	Algae	41.05420	-86.17777
63	MA_63	--	--	muskgrass	41.05420	-86.17777
64	MA_64	--	--	Algae	41.05424	-86.17068
64	MA_64	8		Duckweed	41.05424	-86.17068
65	MA_65	--	--	Algae	41.05531	-86.19107
65	MA_65	1	1	muskgrass	41.05531	-86.19107
67	MA_67	8		Duckweed	41.05534	-86.18398
69	MA_69	--	--	Algae	41.05537	-86.17689
69	MA_69	1	1	muskgrass	41.05537	-86.17689
70	MA_70	--	--	Algae	41.05539	-86.17157
70	MA_70	1	1	muskgrass	41.05539	-86.17157
71	MA_71	--	--	Algae	41.05540	-86.16980
72	MA_72	--	--	Algae	41.05646	-86.19197
72	MA_72	1	1	muskgrass	41.05646	-86.19197
73	MA_73	--	--	Algae	41.05647	-86.19020
73	MA_73	8		Coontail	41.05647	-86.19020
74	MA_74	8		Coontail	41.05648	-86.18842
75	MA_75	1	3	Coontail	41.05649	-86.18665
75	MA_75	8		Duckweed	41.05649	-86.18665
76	MA_76	--	--	Algae	41.05653	-86.17779
77	MA_77	--	--	Algae	41.05654	-86.17601
78	MA_78	--	--	Algae	41.05656	-86.17070
78	MA_78	1	1	muskgrass	41.05656	-86.17070
79	MA_79	5	1	muskgrass	41.05762	-86.19286
80	MA_80	--	--	Algae	41.05763	-86.19109
80	MA_80	8		Duckweed	41.05763	-86.19109
80	MA_80	1	1	muskgrass	41.05763	-86.19109
81	MA_81	--	--	Algae	41.05764	-86.18932
82	MA_82	--	--	Algae	41.05765	-86.18755
82	MA_82	1	1	muskgrass	41.05765	-86.18755
82	MA_82	1	4	Vallisneria	41.05765	-86.18755
83	MA_83	--	--	Algae	41.05765	-86.18577
83	MA_83	1	1	muskgrass	41.05765	-86.18577
84	MA_84	--	--	Algae	41.05766	-86.18400
85	MA_85	--	--	Algae	41.05769	-86.17868
88	MA_88	--	--	Algae	41.05879	-86.19199
88	MA_88	1	1	muskgrass	41.05879	-86.19199
89	MA_89	--	--	Algae	41.05880	-86.19021
90	MA_90	--	--	Algae	41.05880	-86.18844
90	MA_90	1	1	muskgrass	41.05880	-86.18844
91	MA_91	3	1	muskgrass	41.05881	-86.18667
92	MA_92	--	--	Algae	41.05882	-86.18490
92	MA_92	1	1	muskgrass	41.05882	-86.18490
93	MA_93	--	--	Algae	41.05883	-86.18312
94	MA_94	--	--	Algae	41.05884	-86.18135
96	MA_96	--	--	Algae	41.05885	-86.17781
96	MA_96	1	1	muskgrass	41.05885	-86.17781
97	MA_97	--	--	Algae	41.05886	-86.17603
98	MA_98	--	--	Algae	41.05887	-86.17426
98	MA_98	1	4	Vallisneria	41.05887	-86.17426
99	MA_99	--	--	Algae	41.05888	-86.17249
99	MA_99	1	1	muskgrass	41.05888	-86.17249
100	MA_100	--	--	Algae	41.05994	-86.19465
101	MA_101	--	--	Algae	41.05995	-86.19288
102	MA_102	--	--	Algae	41.05996	-86.18934
103	MA_103	--	--	Algae	41.05999	-86.18225
103	MA_103	1	1	muskgrass	41.05999	-86.18225
104	MA_104	--	--	Algae	41.06000	-86.18047
104	MA_104	1	1	muskgrass	41.06000	-86.18047
105	MA_105	--	--	Algae	41.06001	-86.17870
105	MA_105	1	1	muskgrass	41.06001	-86.17870
106	MA_106	--	--	Algae	41.06002	-86.17693
106	MA_106	1	1	muskgrass	41.06002	-86.17693
107	MA_107	--	--	Algae	41.06003	-86.17516
108	MA_108	--	--	Algae	41.06003	-86.17338
108	MA_108	1	1	muskgrass	41.06003	-86.17338
108	MA_108	1	4	Vallisneria	41.06003	-86.17338
109	MA_109	--	--	Algae	41.06114	-86.18491

"--" means ranking not applicable for this species

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8: Plant present but unranked

INJURY RATINGS
1: Healthy
2: Slight Injury
3: Moderate Injury
4: Severe Injury
5: Dead Plant

Site ID	SITE_NAME	DENSITY	INJURY	PLANT	Latitude	Longitude
110	MA_110	--	--	Algae	41.06115	-86.18314
110	MA_110	1	1	muskgrass	41.06115	-86.18314
111	MA_111	--	--	Algae	41.06116	-86.18137
111	MA_111	1	1	muskgrass	41.06116	-86.18137
112	MA_112	--	--	Algae	41.06117	-86.17960
112	MA_112	1	1	muskgrass	41.06117	-86.17960
112	MA_112	1	4	Vallisneria	41.06117	-86.17960
113	MA_113	--	--	Algae	41.05431	-86.17736
113	MA_113	1	1	muskgrass	41.05431	-86.17736
114	DK_1	--	--	Algae	41.06074	-86.19453
115	DK_2	--	--	Algae	41.05925	-86.19483
116	DK_3	--	--	Algae	41.06099	-86.18400
117	DK_4	--	--	Algae	41.06190	-86.18306
118	DK_5	--	--	Algae	41.05557	-86.19252
118	DK_5	1	4	Coontail	41.05557	-86.19252
119	DK_6	--	--	Algae	41.04860	-86.18693
119	DK_6	1	1	muskgrass	41.04860	-86.18693
120	DK_7	--	--	Algae	41.04910	-86.18957
120	DK_7	8		Duckweed	41.04910	-86.18957
120	DK_7	1	1	muskgrass	41.04910	-86.18957
121	DK_8	--	--	Algae	41.04565	-86.18264
121	DK_8	1	1	Coontail	41.04565	-86.18264
121	DK_8	8		Duckweed	41.04565	-86.18264
121	DK_8	1	1	muskgrass	41.04565	-86.18264
122	DK_9	--	--	Algae	41.04945	-86.17435
123	DK_10	--	--	Algae	41.05017	-86.17188

"--" means ranking not applicable for this species

DENSITY RATINGS
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1: 1-20% of rake teeth filled
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INJURY RATINGS
1: Healthy
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